PAPERS

IN

MECHANICS.

N° I.

LIFE-PRESERVER.

The GOLD MEDAL *of the Society was this Session voted to* THOMAS GRANT, *Esq. of Bideford, now of Plymouth, for a* LIFE-PRESERVER *in cases of Shipwreck. The following communications were received from him on the subject, and a Model of the Invention is preserved in the Society's Repository.*

Bideford,
Nov. 27, 1817.

SIR;

OWING to the many fatal cases of Shipwreck that happen every year upon this coast, and circumstances having frequently made it impossible to afford relief to the vessel in distress by means of the best constructed life-boat or captain Manby's mortar; and although a variety of Life-Preservers have been invented for ships, yet probably from their being too complicated or requiring much care and attention none of them have yet been brought into general use.

The loss of sixteen men in the Ellen a few months since (a melancholy event that has left widows and fatherless children in a most deplorable situation) is precisely such a case as above described, and had there been a life boat upon the coast abreast of where she foundered, it would have been impossible for it to have reached her in time to save the crew from perishing—and she was lost at too great a distance from the shore to have effected a communication by means of captain Manby's apparatus; and even had there been a boat on board, she could not have lived in so tremendous a sea: these circumstances have induced me to offer a few observations upon what appears to me the most simple method of saving such valuable lives in future.

I have for some months given up what time I could spare from my official duties to this point, and after a variety of contrivances with different articles, I at length determined upon the conversion of a ship's water cask into a Life-Preserver, which has now undergone many trials, and been found adequate to its important design; it is simple, the expense trifling, and requires no care. All the ships water casks now in use could be converted into Life-Preservers upon this plan in a few hours. The bed and bung once completed, and fourteen iron thimbles and five dozen bottle corks procured, all the rest is sailors work, as the cask is attached to the bed by lashing only, without a single nail in any part of it.

Independant of the bed and all the other apparatus, I allow about one pound and three quarters of cast iron to every gallon of air for ballast, and three gallons of air for each man: for instance, a 36 gallon barrel requires 8 feet of $1\frac{1}{2}$ inch plank, 6 fathoms of 2 inch rope, 15 fathoms of inch line, 5 dozen corks and 63 lb. of cast iron for ballast, and will support twelve men in sea water: it is always at hand, occupies no more than the usual

space, and no part of its apparatus is in the way; for which reasons I presume it will be considered preferable for merchant vessels to any thing else of the sort hitherto invented, however ingenious in construction; for all that is essentially necessary for its preservation is, to keep it water tight, which is done by the use that is made of it for daily purposes, and when a case of danger occurs it is only to cut the deck lashing and discharge the water, to secure the bung, and throw the cask overboard; and the land being to leeward, the wind and sea will set the cask and men towards the shore. Men who from fatigue or cold are unable to hold on, have a seat, and are supported round the back, consequently are carried in perfect safety without any exertion; and from the manner in which the ballast is fixed, the cask will always float steadily, and cannot roll or upset.

No less than twenty-four vessels have been wrecked within the limits of two ports upon the coast in one year, and upon a moderate calculation thirty wrecks at least happen every year between the North side of Bideford bay and the Land's-end: many of which melancholy events, from my official situation, I have been an eye-witness to, and most of them have happened under the circumstances mentioned in the beginning of my letter.

Communication might be effected with the shore by taking one end of a line from the ship.

As the bung hole is made large enough to admit a man's arm, the cask is the sooner emptied, and any valuable property or ship's papers can be put into it. A coaster having but few hands, might save the greater part of their clothes.

It would be advisable upon the first approach of distress to get the cask ready by discharging the water, and after putting into the Life-Preserver whatever might be

thought most essential to save, secure the bung, and when extreme danger obliges the crew to quit the ship, there is nothing more to be done but to cut the deck lashing, and throw the cask overboard.

The cask, the bed, and the rope work, separate from each other in case of any repairs being wanted to either, and to guard against accidents, there is a duplicate of every thing, so that if one or two lashings give way, the rest will support the whole.

I thought it advisable with the view of bringing it into immediate use, to request the mayor and corporation would recommend it to the notice of the merchants and ship owners of this town, when fully satisfied of its utility, and to use their influence to induce them to adopt it in every ship: the reply I received from the corporation and from Sir Richard Keats, I now beg leave to inclose for the purpose of being submitted to the Society for the Encouragement of Arts, &c.

It has already been so well received at this port in consequence of the humane exertions of the corporation to get it into general use, that several of the ship owners have ordered the water casks in their vessels to be made into Life-Preservers, from the one I first constructed.

Various improvements will no doubt be made on this simple invention by mariners of ability, whose observations and experience enable them to form the best judgment of all nautical contrivances.

I feel diffident of my own skill in maritime affairs: I have been actuated in these suggestions only by a wish to prevent the dreadful havoc of lives which yearly occurs upon this iron-bound coast. I beg to add that you will shortly receive a model of the invention, accompanied by drawings, &c. and I shall be most happy if it proves beneficial in saving the lives of shipwrecked seamen under the

peculiar circumstances before described, and trusting that my humble endeavours to assist in the cause of humanity may be approved by the Society of Arts, &c.

I am, Sir,

A. Aikin, Esq. &c. &c. &c.

Secretary, &c. &c. THOMAS GRANT.

Town-hall, Bideford,

SIR; Oct. 31, 1817.

WE have witnessed the experiment this day tried with your newly invented Life-Preserver, being a water cask of 36 gallons, whereby ten men were at the same time kept floating with their heads considerably above the water in a strong current at ebb tide, through Bideford Bridge. The invention appears to us admirably calculated for general benefit, and we consider it well deserving the attention of nautical men, particularly mariners employed in the coasting trade, and the cheapness at which it is procured, the simplicity of its construction and its applicability to the purposes of a water cask on board ship, are in themselves strong recommendations for its adoption.

We are, Sir,

&c. &c. &c.

WILLIAM TENDREW, *Mayor,*
R. G. KEATS, *Recorder,*
CHARLES CARTER, *Justice,*
THOMAS BURNARD, *Alderman,*
THOMAS BURNARD, *jun. Alderman,*
LEWIS WILLIAM BUCK, *Alderman,*
LAWRENCE PRIDHAM, *Capital Burgess,*
THOMAS VILLARETT, *Capital Burgess,*
JOHN HOGG, *Capital Burgess,*
JOHN HANDFORD, *jun. Capital Burgess,*
WILLIAM CALLON, *jun. Capital Burgess.*

Thomas Grant, Esq. Bideford.

Bideford,
December 5, 1817.

THIS is to certify, that we have seen a ship's water cask converted into a Life-Preserver, according to the invention of Mr. Grant, Collector of his Majesty's Customs at this Port, and have no hesitation in saying, that we consider it the best contrived Life-Preserver for merchant vessels we have ever seen, and strongly recommend its being adopted in every ship.

JAMES LILLICRAP *Capt. R. N.*
GUSTAVUS STUPART, *Capt. R. N.*
CHARLES CLYNE, *Capt. R. N.*
RICHARD BUCK, *Capt. R. N.*

When the cask is used as a water cask, it is lashed to the deck in the usual way, for which purpose there is a lashing at each end of the bed the cask stands upon; the longest cork loops *b*; fig. 1, plate 2, are drawn tight round to each end of the cask; the cork lines *q*, coiled up, and the end foot ropes *a*, are all stopt together by a single twine stop, fixed to the end lashing, and stowed between the head of the cask and the lashing, and the side ropes *a*, are put upon the bed, so as to be out of the way.

When a case of danger occurs, the first thing to be done is, to cut the deck lashings, then empty the cask, secure the bung, cut the twine stop, spread the cork lines *q*, at each end, and throw the cask overboard, or lower it down the side by a rope rove through one of the end foot ropes *a*, by which the Life-Preserver can be kept floating near the ship's side till the men are all ready, when they have only to let go the end of the rope, and quit the ship.

The corks make the lines float, and prevent the hands from slipping. The men have thereby a better hold; it also prevents galling when the loops *b* are applied round the back.

§

The smaller cork loops *k*, afford a more convenient hold when the men get close to the cask. Fatigued men can sit or stand on the ropes *a*, and by putting the largest loop *b*, over the head, and getting it under one arm at a time, he will have the bight round his back, as shown in those floating to shore, fig. 5. He is thus secured in an easy seat, and carried in perfect safety without any further exertion.

The bed the cask stands upon is nearly square. The cask might be double-headed, and should be painted of a light colour, that it might be the more readily seen at night.

In approaching the shore, the men should disengage themselves from the foot-ropes *a*, and the loops *b*, before they strike the ground.

The Ballast.

With regard to the ballast, they cast iron to any pattern at the founderies, and all the directions necessary to be given are, that the piece is not to be more than two inches thick, to be nearly square, and to weigh pounds.

The weight of cast iron ballast for common sized water casks is as follows:

A kilderkin (18 gallons) requires a cast iron slab of two inches thick, weighing 32 lb. and will support six men in sea water.

A barrel (36 Gallons) requires a piece of the same thickness, weighing 63 lb. and will support twelve men.

A hogshead (54 Gallons) requires a piece of the same thickness, 95 lb. and will support eighteen men.

The Bung.

The bung should be made in shape of an oblong square, and large enough to admit a man's arm. Saw it out of

a piece of inch thick cork, with a common sash saw, and fit it nicely with a wood file. Cover the top of the bung with a piece of sheet iron, about $\frac{1}{8}$ of an inch in thickness: the hinge and hasp are cut out of the same, and the iron plate rivetted through the thickest part of the cork by five small rivets, the centre one having an eye upon the top, to which the fore-lock that secures the bung is fastened, as shown in the model.

Reference to the Drawing of Mr. GRANT'S *Life-Preserver, in cases of Shipwreck,* Plate II.

Fig. 1, perspective view of the Life-Preserver.

Fig. 2, the upper side of the bed, *e* the eye bolts which receive the lashing; *f g*, the ring bolts to which the foot ropes *a*, are spliced, and which also serve to lift the whole apparatus up by; *h*, eyes rivetted upon iron clamps, which receive the end lashings of the cask, and also the deck-lashing; *m*, three pieces of wood fixed upon the bed, and cut so that the cask bears equally upon all, and the ends of the cask being let into the end pieces, it is prevented from shifting either endways or sideways; *n*, side pieces, which prevent a heavy stroke of the sea from getting between the cask and the bed, so as to act as a wedge that might occasion a great strain on the lashings, and endanger the cask's being separated from the ballast.

Fig. 3, the under part of the bed; *o*, the ballast, which is not to be more than two inches thick, and to be fixed as near the centre as possible; *p*, two wooden ledges about four inches broad, and sufficiently thick to keep the ballast clear of the deck.

Fig. 4, side view of the bed.

Fig. 5, view of the Life-Preserver supporting six men, and drifting from the vessel to the shore.

Mr. T. Grant's Life Preserver. Pl. 2.

Fig. 5.

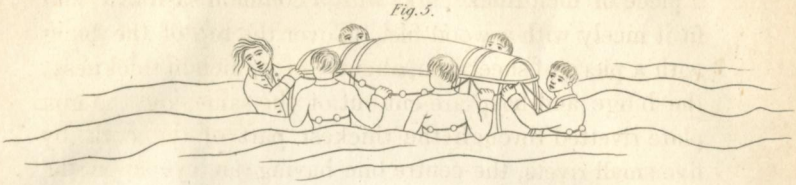


Fig. 2.

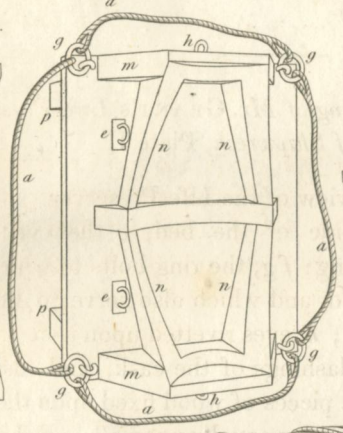


Fig. 4.

Fig. 6.

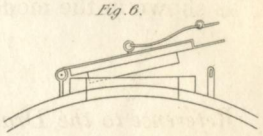


Fig. 3.

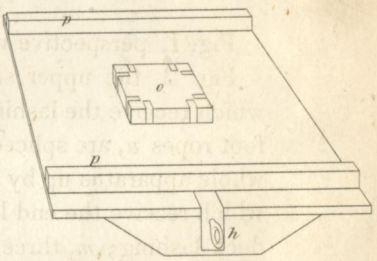
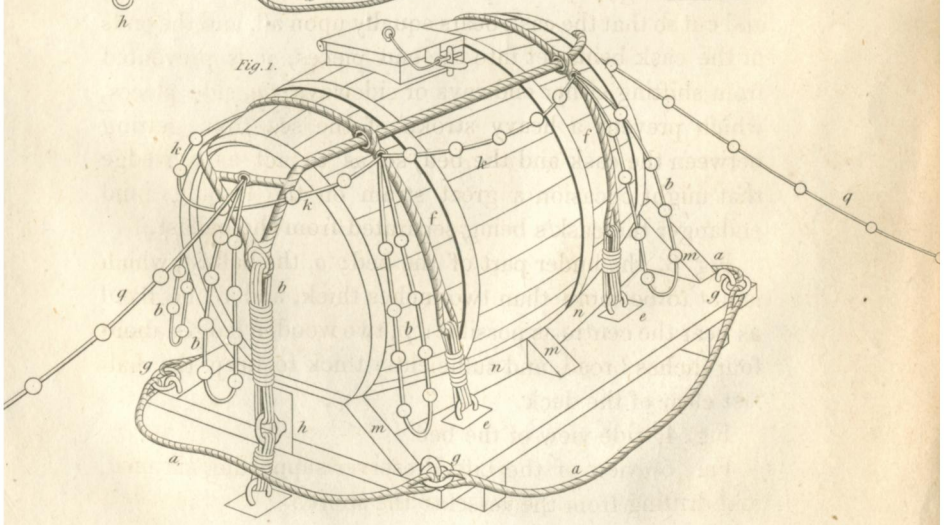


Fig. 1.



Drawn by C. Varley.

Engraved by J.D. Taylor.

Fig. 6, section of the bung and bung-hole, the joint being separated.

N° II.

DOOR-SPRING.

The SILVER ISIS MEDAL *and* FIVE GUINEAS, *were this Session voted to Mr.* J. HENLON, *of Welbeck Street, for a* DOOR-SPRING. *The following communication was received from him on the subject, and a Model of the Invention is preserved in the Society's Repository.*

69, Welbeck Street,
April 28, 1818.

SIR;

YOU will oblige me by laying before the Society for the Encouragement of Arts, Manufactures, and Commerce a model of an improvement which I have made in a Single Door Spring, manufactured by my employers, Messrs. E. and J. Dowson, of Welbeck-street. My object has been to give an increased power to the spring when the door is shut, and thereby an additional resistance to the current of wind in passages, &c. where spring-doors are particularly useful. In a door of the common construction, the springs act with increased power in proportion as it opens, but in that which is the subject of the present communication, I have diminished the resistance, and thus, I trust, have accomplished my object, to make a door to act as pleasantly as possible, where such a contrivance is found

necessary to keep it shut. Should the model sent be thought worthy of the notice of the Society, I shall be happy to attend, and give any explanation in my power.

I am, Sir,

A. Aikin, Esq. &c. &c. &c.

Secretary, &c. &c. JOHN HENLON.

Reference to Mr. J. HENLON'S *Door-Spring,* Plate III.

Fig. 1, represents part of the door frame in section with the whole of the Door-Spring in its place in the top of the door, the door, however, being removed to show it.

a, the upper frame; *b,* the post to which the door is hinged; *c c,* the plate of the spring which is fastened on the door by the screws *d d; e,* a screw which holds the cock *f,* in which the wire *g h,* is secured, but so as to turn round at the end *h,* which is nicked for a screw driver; round this wire is wrapped the steel wire spring (shown fig. 2.); *i,* an iron bar with a ring *k* (fig. 2) fixed to it, through which the wire *g h,* passes: the spring presses against this ring, and keeps the bar at that end: the other end of the spring acts against a nut *l,* which is screwed on the wire: *m,* a perforated plate, screwed to the door frame, above which the wood is cut away to make room for the roller *n;* this roller is connected by the moveable arm *o o,* to the bar *i,* against the end of which the Spring acting keeps the door shut. Fig. 3, a bird's eye view of the door shut, the upper frame (to which the plate *m,* is screwed by the holes *p p,*) being removed; the leverage by which the door is held, is nearly as long as its thickness, and this length decreases as much as the moveable arm *o o,* and roller *n,* approach the door hinge *q.*

Fig. 4, shows the door opened at right angles to the

Mr. J. Henlon's, Door Spring.

Pl. 3.

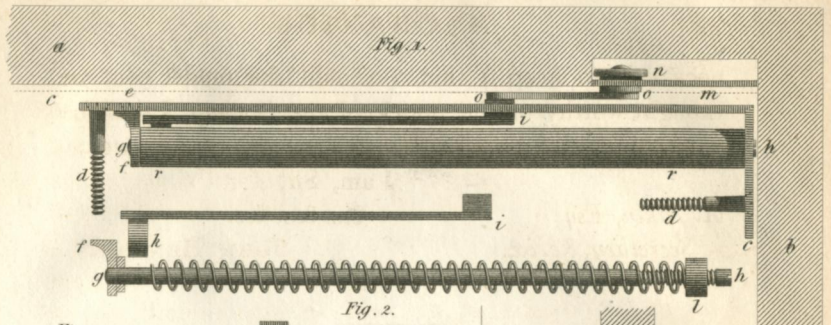


Fig. 2.

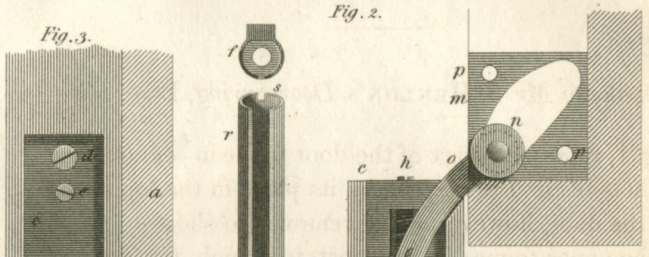


Fig. 6.

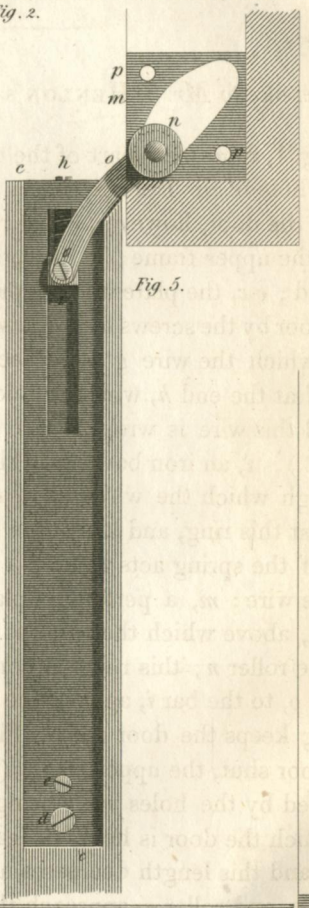


Fig. 5.

Fig. 7.

Fig. 4.

Drawn by C. Varley.

Engraved by J. B. Taylor.

frame, by which the roller *n*, has travelled from one end of the perforation to the other next the hinge, and reduced the lever to one quarter of its length from the hinge, and consequently lessened in the same proportion its power to shut the door.

Fig. 5, shows the door opened quite back, now the moveable arm *o o*, lies over the hinge, and therefore the spring, though increased in action, has no power to move the door; but if made to pass the hinge a little farther, will hold it open. Fig. 6, *r r*, an iron pipe, open on the upper side; this goes over the spiral spring, and one end fits on the neck of the cock *f*; the notch and pin at *s*, keep it from turning round; the open side makes way for the end *k*, of the bar *i k*, to travel, the other end fits on the screw nut *l*; this nut has a neck which, rising through the open side of the pipe *r r*, is prevented from turning round (shown separate fig. 7), and by turning the wire *g h*, with a turn-screw, the nut advances to increase the force of the spring if required.

N° III.

RULER AND QUILL-HOLDER.

The SILVER MEDAL *was this Session voted to Mr.* T. LANE, *of Stockwell, for a* RULER *and* QUILL-HOLDER. *The following communications were received from him on the subject, and a Model of the Invention is preserved in the Society's Repository.*

Chapel Street, Stockwell, Surrey,
March 16, 1818.

SIR;

I REQUEST that you will have the goodness to lay before the Society of Arts, &c. two instruments of my invention, for the purpose of enabling a person who has lost one hand, to make or mend a pen, and to rule lines. The occasion of my inventing these instruments was the following: Some time ago I was applied to by a gentleman who, having had the misfortune to lose his left hand, had come to London in order to procure some mechanical substitute which might enable him to pursue his occupation as usher in a school. After taking the subject into consideration, I made models in wood of the instruments alluded to, which, in the opinion of the gentleman, gave such fair promise of success, that he authorized me to get them completed.

It will be seen from the subjoined letter, that in fact they have completely fulfilled the object in view, on which

account I am induced to lay them before the Society, in the hope of obtaining their approbation, and thereby of rendering the invention more extensively known.

I am, Sir,
&c. &c. &c.
THOMAS LANE.

Gloucester,
SIR; October 21, 1813.

I RECEIVED the Pen-mending machine and Ruler which you contrived for me, and I am glad to inform you that I find them both of great service.

My continual engagement in the business of our school, has occasioned this long delay of due acknowledgments for your very ingenious invention, which so well supplies the unfortunate loss of my left hand.

I hope my letter will arrive in time for the purpose you mentioned, and you may be assured that I shall, on all occasions, rejoice in bearing testimony to your skill in contriving these useful instruments.

I am, Sir,
&c. &c. &c.
THOMAS HOLMES.

Gloucester,
SIR; October 21, 1813.

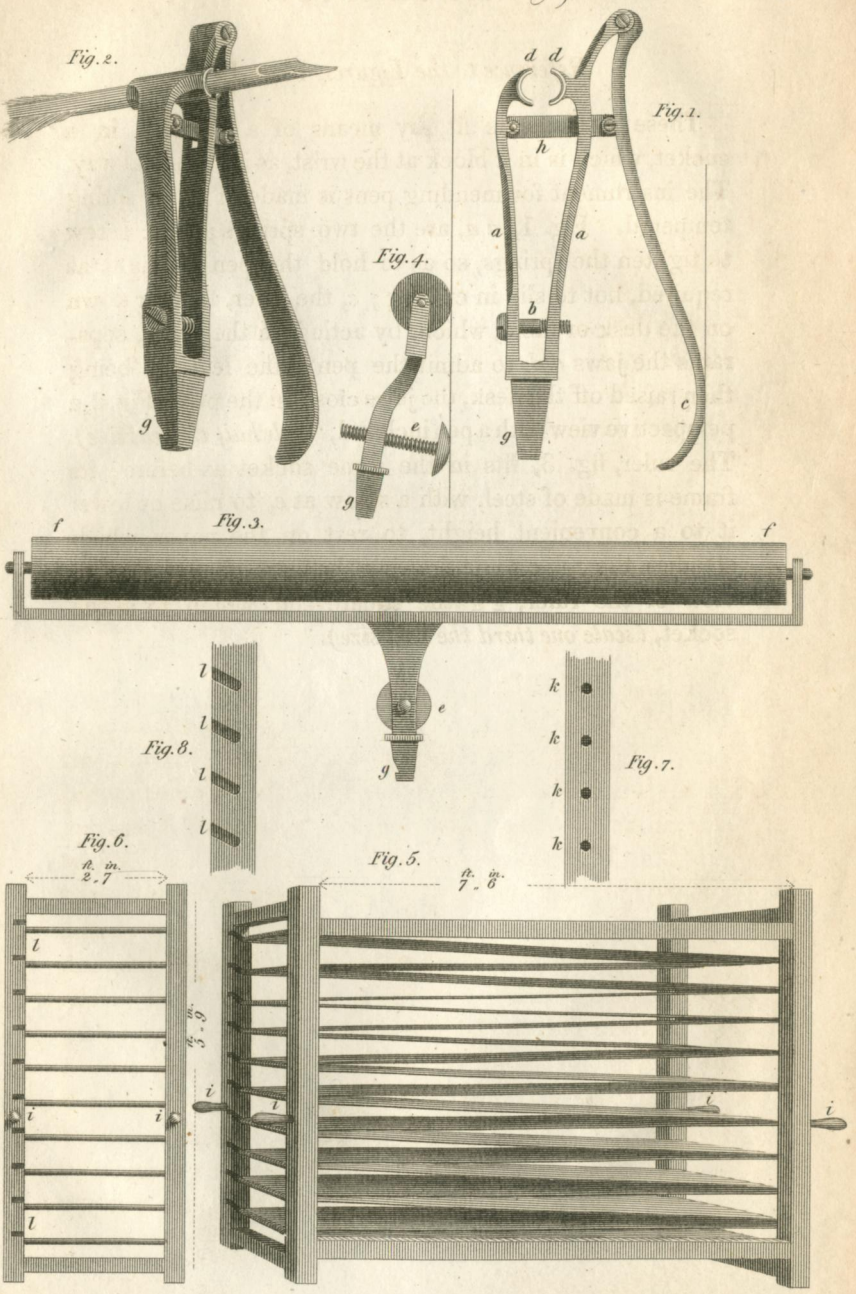
AT the desire of Mr. T. Holmes, Rev. Richard Raikes most readily attests the efficacy of his Pen-mending machine and Ruler.

RICHARD RAIKES.

Reference to the Figures, Plate IV.

These instruments fit, by means of a notch *g*, in a socket, which is in a block at the wrist, as in the usual way. The instrument for mending pens is made of steel spring tempered. Fig. 1, *a a*, are the two springs; *b*, a screw to tighten the springs, so as to hold the pen as tight as required, not to slip in cutting; *c*, the lever, to bear down on the desk or table, which, by acting on the bar *h*, separates the jaws *d d*, to admit the pen; the lever *c*, being then raised off the desk, the jaws close on the pen. Fig. 2, a perspective view with a pen inclosed, *(scale half the real size)*. The ruler, fig. 3, fits in the same socket as before; its frame is made of steel, with a screw at *e*, to raise or lower it to a convenient height, to rest on the paper, which steadies the ruler while drawing the line. Fig. 4, an end view of the ruler, *g g* the square ends which fit in the socket, *(scale one third the real size)*.

Mr. T. Lane's, Pen-holder & Ruler. Pl. 4.



Drawn by C. Varley. Engraved by G. Gladwin.

Mr. S. Brierly's Sketch for Woollen Weavers.

N° IV.

MACHINE TO PREVENT ACCIDENTS IN DESCENDING MINES.

The SILVER ISIS MEDAL *was this Session voted to Mr.* G. PRIOR, *of Howard's Green, City Road, for a* MACHINE TO PREVENT ACCIDENTS IN DESCENDING MINES. *The following communications were received from him on the subject, and a Model of the Machine is preserved in the Society's Repository.*

SIR; May 10, 1807.

IN consequence of the late misfortunes which have happened in this part of the country, by the breaking of the ropes by which men and coals are let down and brought up at coal pits, I have been induced to visit them, and see if I could not discover some method or other by which such misfortunes could be prevented. I find the coal pits have an upright sliding frame, made of wood, cased with iron from top to bottom, supported in different parts by beams across the pit, on which a frame slides, made very strong of iron, to prevent the rope from untwisting when a weight is applied at the end of it. I have represented a coal pit in the model inclosed, with the sliding piece or frame which supports the corve or bucket as they are used; to which is added an invention by which I hope such accidents will in future be prevented, where it may be applied.

It is not at all necessary for me to give any explanation of the machine, on account of its simplicity of construction, as its advantages will appear by hanging on the weight to the frame which slides on the upright pieces which go down into the Pit, and hooking on the string at the top which will allow it to be raised or lowered without any obstruction. By slipping the ring from the hook at the top of the frame which supports the weight, the effect will be the same as if the rope had actually broken; and you will find the instant the rope is let loose, two powerful clicks, with centres of motion on the side of the moving frame are brought into action: the arms of these clicks go through holes cut in the sides of the frame, and meet each other in the middle in such a manner that a bolt may pass through them, and at the same time through a block which is astride the bar which holds the frame together: at the top of this block is a hook to which the rope is fastened. When in use, the rope bearing the sliding frame with the corve or bucket, pulls the heads of the clicks close up to the bar which is over them, and draws their ends from the sides of the sliding frame which goes down to the bottom of the pit, which is armed with strong iron pieces driven or screwed into them at small distances.

In case of accident by the rope giving way, the clicks instantly present themselves to the sides, by the elasticity of the springs which are under them, screwed fast to their frame, which may be made very strong, as there is no danger of their breaking, being required only to bend so little. Elasticity being much quicker in its action than gravity, the frame with the corve or bucket is sure to be stopped by the first bolt they meet with, and will remain suspended in the pit until another rope can be procured by which means the lives of the men in the bucket will be preserved. If by the concussion at any time the bolt which passes through the joint of the click should

break, the sides of the frame will instantly become the fulcrum, and will not in the least prevent the click from action, but will in fact press it tighter against the upright pieces to which the bolts are affixed. The clicks, when the rope is attached, have not any weight to support on their joints, as their heads through which the bolt passes in the block support or rest themselves against the beam which combines the sides of the frame together.

I am, Sir,

A. Aikin, Esq. &c. &c. &c.

Secretary, &c. &c. GEORGE PRIOR.

Reference to the Engraving of Mr. PRIOR'S *machine.*

g g, figs. 2 and 3, represent the iron frame to which the corve or basket is attached; *h h* is the upright slider fixed on the inside of the coal pit shaft, which fitting into a groove in the frame *g*, fig. 3, serves to direct the motion of the frame as it is raised or lowered.

b, figs. 1 and 2, is the hook by which the frame is suspended to the rope. This hook is shown more in detail, fig. 7, in which the upper eye receives the cross bar of the frame, and the lower eye with its bolt secures the extremities of the bars or clicks *c e*, fig. 1, which form part of Mr. Prior's invention. Each of these clicks is attached by its angle to a projecting piece of the frame *d*, figs. 1, 2, 5, which serves as the centre of motion to the click; *f f*, figs. 2, 5, are strong springs fixed to the outside of the iron frame, and bearing on the clicks with a constant tendency to throw them outward.

The action, therefore, of Mr. Prior's contrivance is obvious. While the frame remains attached to the rope, the arms *c c* of the clicks being raised somewhat above a horizontal position, overpower the springs, and press the other arms, *e*, of the clicks close to the sides of the frame, as shown in fig. 1. But when, in consequence of the

rope breaking, no counteraction is opposed to the springs, these, acting on the arms *e*, throw them out so as to cause them to catch on the nearest cog of the upright slider *h h* and thus prevent the descent of the frame, as represented in fig. 2.

Fig. 4, shows the two clicks bolted loosely together by their short arms, and perforated at their angles by a small hole through which the bolts pass, which are their respective centres of motion; and which bolts are secured in the piece *d*, figs. 2, 5.

Fig. 8, shows the frame with the corve, suspended in the middle of the shaft by the action of the clicks, the rope having broken.

N° V.

PERCUSSION GUN LOCK.

The SILVER MEDAL *was this Session voted to Mr.* COLLINSON HALL, *of High Street, Mary-le-bonne, for a* PERCUSSION GUN LOCK. *The following account contains the substance of the communications received on the subject.*

THE cock, or hammer, and the touch-hole are the only parts in which Mr. Hall's gun differs from those in ordinary use; and these parts are so simple that a common lock may be converted into a percussion lock on Mr. Hall's plan, at a very small expense.

The detonating powder which is used for the priming is made into the form of a pellet, and is fixed in the centre of a small round piece of paper covered with wax. In

Mr. G. Priors, machine for preventing accidents in descending mines.

Pl. 5

Fig. 8.

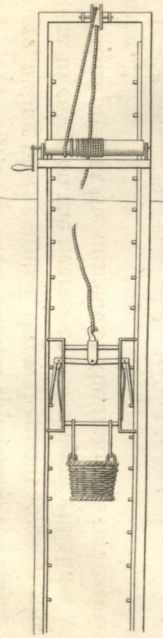


Fig. 1.

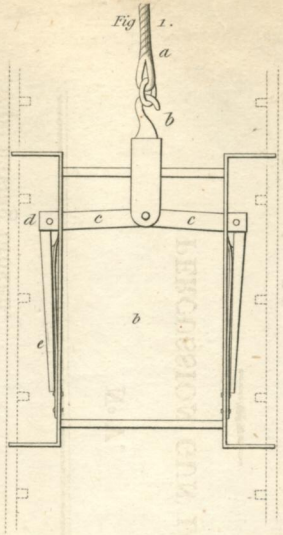


Fig. 2.

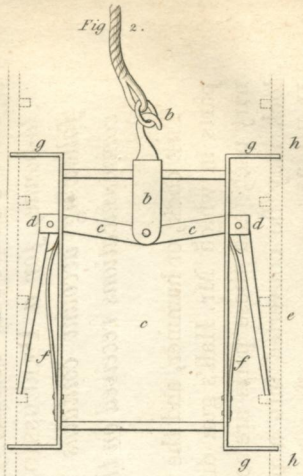


Fig. 5.

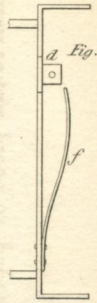


Fig. 6.

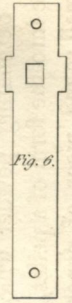


Fig. 4.

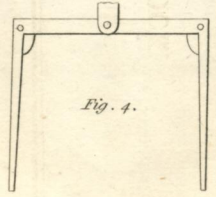


Fig. 3.

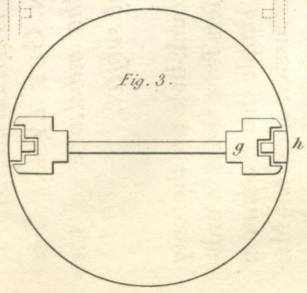


Fig. 7.

Drawn by J. Newton.

Engraved by J.B. Taylor.

this state it is applied to a cavity countersunk in the head of the hammer, to which it adheres by means of the wax, and is thus preserved from the effect of wet. The touch-hole consists of a cylindrical plug screwed into the side of the barrel, and having a pin or nipple projecting from it at right angles: this pin is perforated in the direction of its axis, and thus forms a communication with the powder in the cavity of the plug. When, by the release of the tumbler, the hammer is let go, the countersunk cavity, containing the patch of detonating paste, strikes on the top of the pin of the touch-hole, the paste explodes, and communicating its percussion through the perforation of the pin, fires the powder in the cavity of the plug, and thus discharges the gun. The corrosive and deliquescent salt resulting from the decomposition of the detonating paste can act only on the hollow of the hammer, where it does no material injury, instead of soiling and occasioning damp in the touch-hole itself. Hence a lock on this construction hardly ever misses fire, and the discharge is remarkably rapid; both of them circumstances which very materially influence the success, and consequently the satisfaction of the sportsman.

The detonation is so powerful, that if a card be laid over the pin, or even if its perforation be stopped with tallow, the gun will, notwithstanding, be discharged. If the hammer is let down gently after priming, the spring presses the pellet close into the cavity, and thus considerably increases the effect.

The paste is made of the several ingredients in the following proportions, viz.

	Grains.
Oximuriate of potash	196
Flour of Sulphur	68
Fine powdered charcoal	34
Gum Arabic	12

Dissolve the gum in as little water as possible; then grind the oximuriate of potash fine, in a Wedgewood's mortar, by itself, and also the flour of sulphur and charcoal together, with a pestle of the same material. The mixture of all with the gum must then be effected, either in a wooden mortar with a wooden pestle, or, at any rate, in a Wedgewood's mortar with a wooden pestle, taking care to keep it moist during that operation, lest it should explode.

The paste, being of the consistence of soft clay, is then to be formed into pellets, by means of a mould, made of a plate of brass or copper, one-sixteenth of an inch thick, and filled with holes of one-eighth of an inch in diameter: this plate being placed upon a table, or other flat surface, over which a sheet of paper is first to be laid, the paste is to be spread evenly over its surface, and then pressed into the holes, either by passing a roller over it, or by beating upon it with a wooden mallet: the paste is then to be removed from the upper face of the mould, with a thin spatula or palette knife; and the mould is next to be slided, for the length of an inch, along the paper, to separate the paste from it; and it may then be lifted up, and the pellets carefully driven out of the holes in it, by striking upon it with a soft brush; they are then to be dried. The round paper patches being cut by a proper punch are covered on one side with bees wax mixed with a little tallow, and coloured red to distinguish the adhesive side from the other: the pellet is then gently pressed on the centre of the waxed side of the patch, to which it adheres, and the priming patch is thus completed.

When used, the patch is to be pressed firmly into the countersunk cavity of the head of the hammer, to which it easily adheres in consequence of its waxed surface being in contact with the metal.

The following recipe for the composition of the pellets has been communicated from another quarter.

Take oximuriate of potash 49 grains, flour of sulphur 17 grains, pulverized charcoal 8½ grains. Mix the three ingredients in a wooden mortar, with a tea-spoon full of weak gum water, making it about the consistence of bookbinders paste. Have ready a piece of copper or brass plate, pierced with circular holes of one eighth of an inch diameter, lay it on a board, and spread the composition over it, so as to fill up all the holes. Allow twenty minutes for the paste to harden, push the pellets out with a wooden punch that fits the holes, and spread them to dry more completely, after which they may be fixed with any adhesive composition upon small circular pieces of thin paper for use.

Many testimonials in favour of Mr. C. Hall's invention from persons who had used it for some months, accompanied the original communication, but which it is not thought necessary to insert here. They remain, however, in possession of the Society, as also does a model of the lock.

Explanation of the Figures.—Plate VIII.

a, fig. 1, the lock-plate of a common gun, with the hammer and feather spring removed, and the screw holes plugged up; the pan also being filed off level with the lock plate and bevelled to drain the rain off.

b, the hammer placed on the axis of the tumbler in place of the cock.

c, a plug screwed into the breech where the touch-hole formerly was; which plug is perforated through its whole length at right angles to the axis of the barrel.

d, a small pin or nipple left on the plug, through which a hole is bored at right angles to the axis of the plug. The top of the pin is so placed as to strike directly on the centre of the priming patch in the head of the hammer, when the hammer is released, as shown by the dotted arc, *f f*.

e, a bush made of platina screwed into the end of the plug, and perforated by a capillary tube, in order to moderate the effect of the detonation, and thus prevent the powder from being blown out of the plug before it is ignited.

Fig. 2, is a front view, the barrel being cut off close to the plug.

Figs. 3, 4, are a lateral view and section of the plug.

Fig. 5, is a section of the hammer to show the cavity *g*, in which the patch is deposited.

Figs. 6, 7, a plan and elevation of the patch.

N° VI.

MOORING BLOCK.

The GOLD MEDAL *of the Society was this Session presented to Mr.* J. PARK *of Portsmouth, for his* MOORING BLOCK. *The following communications were received from him on the subject; an explanatory engraving is annexed, and a Model of the Invention is preserved in the Society's Repository.*

Portsmouth-yard,
GENTLEMEN; March 25, 1818.

I TRUST that the communication which I am about to lay before you will not be deemed altogether undeserving your notice.

In October 1795 I was appointed junior master attendant of Portsmouth yard, and as the security of his ma-

jesty's ships and all works on float, relative thereto are in the master attendant's department exclusively, I applied myself as much as possible to gain a thorough knowledge of the harbour, as well as of the nature of the security and disposition of the moorings, and the more I became acquainted therewith, the less satisfied I was with the method by which the ground chain was secured, as a national evil attended it, and various other inconveniences to the public service.

The evil alluded to was that of throwing some thousand tons of shingle ballast annually on what is called the *claws* of the moorings to render them secure, which ballast was by the wash of the tide carried into the bed of the harbour and lakes where the ships ride.

Having arrived at the head of my department in April, 1812, I ventured humbly to recommend to the honourable Navy Board, considerable alterations in the arrangement of the moorings, which would not only tend to improve the harbour by giving more space in the lower part, where the same was required for ships to pass and repass, but also afford accommodation to a greater number of them than hitherto could be laid up; the recommendation being favourably received, I was directed to proceed accordingly.

These alterations were effected, but the great and growing evil of filling up with ballast a harbour already too shallow, still continued, and produced an anxious wish for some substitute for the claw, by which the application of shingle ballast might be discontinued. I was accordingly induced to make several experiments, and after various trials, I submitted to the navy board a model of a cast iron Mooring Block which appeared to promise fair to do away every objection arising from the method of securing the ground chain, being at once a substitute both for claws and mooring anchors.

The Board directed two to be cast of such form and

weight as I wished, and when received in the yard, trials to be made to ascertain what degree of resistance they possessed.

When received, trials were made under the inspection of several experienced and distinguished naval officers, and the principal officers of the dock yard; which proving satisfactory, induced me to address the Navy Board on the 2nd November, 1814, detailing my sentiments, &c. relative to Portsmouth harbour, and the moorings, accompanied by accurate statements of the trials made with the blocks, copies of which I have annexed hereto, having first obtained the Board's permission to do so.

A trial being ordered on a lighter block, and proving equally satisfactory, directions were shortly after given for their general adoption, to the exclusion of every thing hitherto used for securing moorings, and a contract immediately entered into for the supply of them.

The superiority of the block in question over both claws and anchors is manifest, it will last for ages without repair, will resist much greater power than either, and completely obviate the use of shingle ballast, to render the mooring secure (which must hitherto have been extremely injurious to the harbour) as on applying a strain it has a tendency, arising from its form, to bury itself more and more under the surface until it becomes fixed; it is likewise free from liability to be hooked by ships' anchors, and the moorings thereby rendered insecure, which has been the case hitherto, as represented in my letter to the Board above quoted.

I now beg leave to notice the Mooring Blocks in an economical point of view.

The largest blocks, adapted for first-rates' moorings, are now supplied for less than half the sum required to provide and fix what is termed a claw, and about a quarter of the cost of a mooring anchor.

It must also be considered that both the anchor and

claw would require to be replaced in the course of 40 or 50 years (supposing them to remain undisturbed) besides which the claw would require frequent repair from the effect of the worm during that period.

On the blocks already laid down at this port (although principally as substitutes for claws) there arises a saving to the public of upwards of £.3,000; and where it may be necessary to lay them down instead of anchors, the saving will be infinitely greater.

It may not be amiss to mention that an opinion prevailed that the block invented by me was only an improvement on one invented by Mr. Hemmans of Chatham Dock-yard some years ago, but on an examination of the two by a committee of the Navy Board, the same was clearly proved to be erroneous: the report to the Admiralty on that subject, and recommending the general adoption of my block, was as follows, viz.:

"The Committee has further to remark, that Mr. Park's Block cannot be considered as an improvement on the plan of Mr. Hemmans, being totally dissimilar; but altogether as a new invention, and having the same object in view."

As a model and drawing of the block are forwarded, I decline giving any written description of it here, but should the Society require further particulars, I shall have much pleasure in furnishing them.

I have only now to observe, that having been influenced by a strong sense of public duty, and an ardent desire to be useful to my country by overcoming the serious evils set forth in my narrative, I trust it will not be considered too presuming to request as a mark of your approbation that you will be pleased to give my invention publicity.

I am, Gentlemen,

A. Aikin, Esq.
Secretary, &c. &c.

&c. &c. &c.

J. PARK.

Copy of a Letter addressed to the Hon. the Navy Board.

Portsmouth-yard,
HONOURABLE SIRS; Nov. 2, 1814.

HAVING from my first appointment to Portsmouth yard as junior master attendant, dedicated as much time and attention as in my power towards acquiring a thorough knowledge of the harbour, both as to the depth of water and quality of the ground, and also to the method of preparing and laying down moorings, together with any improvements that might be made, either for their security or for increasing their numbers by a more advantageous arrangement, or by laying down additional ones where found practicable.

I have in the course of my practice (which has been now upwards of 19 years), experienced many inconveniences, which I have long conceived might be removed by making some alteration in the manner of securing the ground chain.

I have likewise been of opinion from an early period after my appointment that many advantageous alterations might be made among the moorings in various parts of the harbour, as well as that new moorings might be laid down both for ships of the line and frigates in the different lakes, and having submitted the same to your Honourable Board by letters of the 30th April, 1812, and 26th July, 1814, was directed by your warrants of the 8th May, 1812, and 28th July, 1814, to carry the propositions into effect: in consequence of which, several alterations have been made, and many new moorings laid down, and much may yet be done when the other duties of the port will admit; but as I am preparing a plan of the harbour, which will show the alterations, &c. much plainer than any written description, I shall decline saying more at present, and endeavour to describe the manner of securing the ground chain, with the inconveniences alluded to.

The ground chain of all the swinging moorings in the harbour is secured as follows:

One end is fixed to what is termed a claw, namely, a frame of wood, with an iron ring in the front for shackling the chain to, which claw is buried below the surface from 2 to 3 feet, by digging away the mud or ground as near the low water mark at spring tides as circumstances will admit, with piles driven in the front, and when completed, the mud which has been removed is thrown on the claw so as to cover it.

The other end of the chain is secured by a mooring anchor, namely, two anchors of about 70 cwt. each, in one stock, with their upper hooks either taken off or beaten down on the shank; this is for line of battle ships moorings; frigates moorings have only one anchor of about 60 cwt.

From this harbour having for some years become a rendezvous for ships in the transport service, and thereby crowded with ships of that description, together with the liability of the mooring anchors, from their construction, to be hooked by the transports anchors, much inconvenience, labour and risk have been experienced, and many instances have occurred when it has been necessary to take up a mooring from end to end, in consequence of ships having hooked the mooring anchor, and regardless of every thing but the recovery of their own anchors, have hove down unobserved in the night-time at low-water, and by the rise of tide, forced the mooring anchor out of the ground; nor did I ever find one so displaced when taken up, entire; but, on the contrary, one anchor has been lying across the other, the stock broken or gone, or the chain foul of the flooks, and I have seen instances when the mooring anchors have been completely upset and found with the flooks uppermost. Having described the swinging moorings, and also what I humbly consider

objections to the anchors, and the principal inconveniences arising therefrom (I say principal, because there are others, particularly where the anchors lie in shoal water, the frequency of their being injured by ships grounding on them, &c.)

I have now to state that all the head and stern moorings in the different lakes are secured by claws only, the chain being laid from shore to shore, and each end shackled to a claw; this method of securing the chain is not however in my opinion, without objections, and to which I humbly call the attention of the Board.

Notwithstanding the claws are perfectly buried when laid down, yet in the course of twelve months they appear above ground, and frequently require a supply of shingle ballast to be thrown on them, particularly in the lakes where the stream is narrow; and as the disappearance of this ballast can only be accounted for, by its being washed down by the tide into the bed of the harbour and lakes, I cannot divest myself of the opinion that the same must prove detrimental to the harbour.

These considerations induced me to search for a substitute, free from such objections, to answer the purpose either of the claw or the anchor, and after making various trials I submitted for the inspection of the committee of your Honourable Board, who visited Portsmouth in September, 1813, the model of a cast iron block, when they were pleased to give directions for two being provided, and your Honourable Board have also directed, by warrant of the 6th July last, the two blocks to be received and tried; they have accordingly been received, and trials made with every possible power, applied to ascertain their stability; and as every one who has witnessed the experiments is fully convinced of the superiority of the blocks, I trust I shall not be considered too presuming in recom-

mending their adoption for claws as well as anchors, as I am given to understand the cost will not much exceed the expense of making and fixing a claw, which is liable to injury, by vessels grounding on, or hooking fast to it, nor is its durability beyond 40 or 50 years, even where it remains undisturbed, whereas the cast iron blocks will last for many centuries.

I am likewise informed that the Blocks may be cast at the foundry, in the yard, if your Honourable Board should approve of a furnace being erected for that purpose, which would materially lessen the expense.

I have hereunto annexed a description of the trials, and and have forwarded by this night's coach, two drawings.

No. 1, showing the present method of securing the ground chain.

2, showing the manner in which the Mooring Block was tried.

And by Clark's waggon, a model of the Block.

I am, Sir,

&c. &c. &c.

J. PARK.

Description of the Trials made with the Cast Iron Mooring Block, invented by me, and now humbly submitted for the consideration of the Honourable Navy Board.

FIRST, The Cast Iron Mooring Block, weighing 142 cwt. was placed on the shore some distance from low water mark, and an anchor of 85 cwt. (exclusive of the stock, which weighed about 35 cwt.) was also placed the same distance from low water mark, and 65 fathoms from each other, on ground of the same quality; 15 fathoms of mooring chain were attached to each, and to the end of each chain four treble blocks of 22 inches; four three-

fold purchases of new 6 inch hawser rove, and two mooring lighters, with 40 men in each, grounded, one abreast of the cast iron block, and the other abreast of the anchor; the falls were brought to the capstans and windlasses, and the strain applied to heave the Mooring Block and anchor towards each other.

Both drew; the former one inch to one foot of the latter, until the Mooring Block had drawn about the distance of its own base, when having completely buried itself, it became stationary, but the anchor continued to come home (notwithstanding it was buried to the upper flook) until every one present was satisfied that any farther trial with an anchor of that weight was useless.

Second, being willing to make further trial, I caused an anchor of 95 cwt. (namely, the Nelson's best bower) to be laid down as before, and the same purchase to be applied; but the power not being sufficient to move either the block or anchor, 10 additional men were sent into each lighter, when the anchor started, and continued drawing, notwithstanding it soon buried itself as the former had done) but the Block remained immoveable.

Although this trial was very satisfactory, yet wishing to ascertain the power of resistance which the Block possessed, I caused the following one to be made.

Third, an anchor of 41 cwt. was laid down about 60 feet behind the large anchor, and attached to it by cable, and on applying the same purchase as above, the large anchor drew until the cable between the anchors became taught, when it was found necessary to increase the power, which, being done, both anchors started, and continued to come home, until the superiority of the Mooring Block (which still remained firm) was declared to be so manifest, that no further experiment was necessary, it being the opinion of the gentlemen under whose inspection this last trial was made, viz. Admiral Sir Richard Bickerton,

baronet; Rear Admiral Foote; Commissioner the Hon. Sir George Grey, baronet; Captain Sir James Athol Wood Hewit, and the principal officers of the Dock Yard; —that it was much superior to any thing yet offered for the purpose of securing the ground chain of the moorings, and that its introduction would prove advantageous to the service, particularly in shoal water where ships had to pass over the anchors.

J. PARK.

Statement of Trials made with a lighter Cast Iron Mooring Block.

First, the Mooring Block weighing 115 cwt. was placed on the shore near low water mark, and also an anchor of 95 cwt. (exclusive of the stock) about 65 fathoms from each other, with 15 fathoms of mooring chain attached to each, and to the end of each chain 4 treble blocks of 22 inches, 4 three-fold purchases of new 6 inch hawser rove, and 2 mooring lighters, with 50 men in each grounded, one abreast of the Mooring Block, and the other abreast of the anchor; the falls were brought to the capstans and windlasses, and the strain applied to heave the Mooring Block and anchor towards each other (similar to the trials made with the former block, a statement of which accompanied my letter of the 2nd of November last).

The block and the anchor both drew about the distance of seven feet, when the block became fixed, but the anchor continued to draw as long as the purchase was applied.

Second, an anchor of 43 cwt. was laid down about 10 fathoms behind the large anchor, and attached to it by cables (termed by seamen, "backing an anchor") when the purchase was again applied by 64 men in each lighter: the large anchor drew, taking the small one with it, until the latter had buried itself up to the crown, when the

anchors became stationary, and the block began to draw, and continued to do so while the strain was applied.

Third, having removed the anchor of 43 cwt. and laid down one of 23 cwt. instead, at the distance of 15 fathoms behind the large anchor, the same purchase was again applied, when both anchors came home.

The block, after having drawn about 7 or 8 inches, became fixed, but the anchors had drawn 13 feet, and kept coming home as long as the purchase was continued, and until it was evident that the block was superior to the anchors.

The foregoing trials were made under the inspection of Admiral Sir Edward Thornbrough, K. C. B.; Rear Admiral Halkett; Commissioner the Hon. Sir George Grey, bart.; Captain Hewitt; the Master Shipwright, Master Attendant, Engineer and Mechanist, &c. &c. &c.

J. PARK.

Reference to the Engraving of Mr. J. PARK'S *Cast Iron Mooring Block,* Plate VIII.

A A A A, the extent of the lower flat of the block.

B B B B, the extent of the upper flat.

C C, for lowering the block into its place.

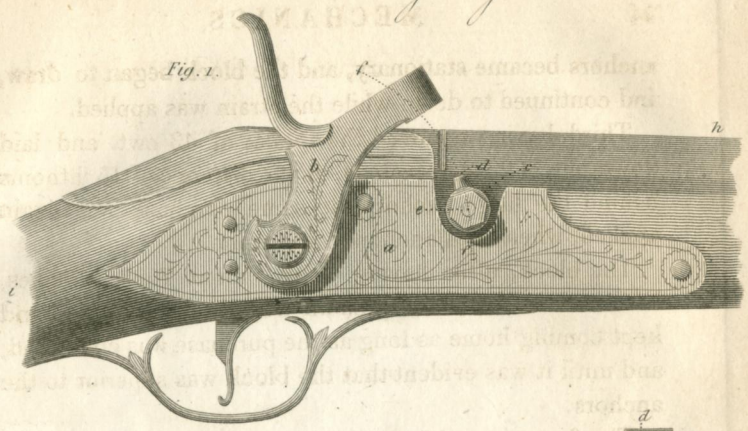
D, the neck of the block, to which the chain is attached.

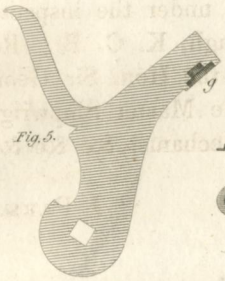
E, the shackle which connects the mooring chain to the block.

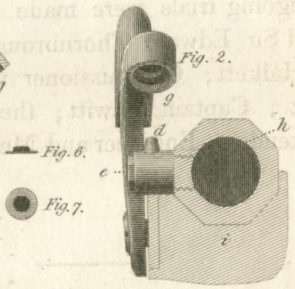
Side View.

F G gives the block an inclination to dive into the ground, when strain is applied.

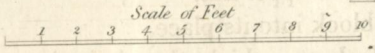
Mr. C. Halls, Percussion Gun Lock. Pl. 8.

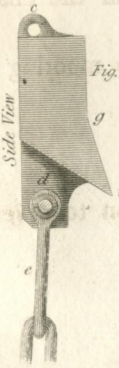


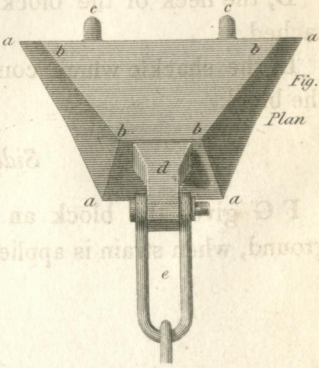




Mr. I. Parks, Cast Iron Mooring Blocks.







Drawn by W. Newton.

Engraved by G. Gladwin.

N° VII.

IMPROVED METHOD OF HEATING COPPER PLATES.

The GOLD ISIS MEDAL *was this Session presented to Mr.* JAMES RAMSHAW, *Copper Plate Printer, Fetter Lane, for an* IMPROVED METHOD OF HEATING COPPER PLATES. *The following communication was received from him on the subject, and Drawings of his Invention are preserved in the Society's Repository.*

33, Fetter Lane, Fleet Street,
March 10, 1818.

SIR:

I BEG leave, through your hands, to present for the approbation of the Society of Arts, &c. a representation of my Apparatus for an improved Plan of Copper Plate Printing, by the use of steam in the place of charcoal fires, the effluvia of which are so injurious to the health of the work-men, and at the same time subject to many accidents by fire, as by the old process, each man works over a charcoal fire, without any chimney to carry off the vapour arising from the burning charcoal. Thirteen of those fires I formerly had in my work-shops, and one sea-coal fire or stove in my drying room, fourteen fires in the whole: by my new process, the use of the thirteen charcoal fires is superseded. A full representation of the apparatus, with the mode of application, will be given by referring to the accompanying drawing, which is a section of my premises, employed in the Copper Plate Printing

*

business. A, Plate VII, is the fire-place; B, a small boiler, containing only thirty gallons of water, with two safety-valves; C C C, are the pipes for conveying the steam to the plate boxes, D D D; these boxes are of cast iron, thirteen in number, and supply the place of thirteen charcoal fires; they have a flat surface, 16 inches square, half an inch deep at the sides, running to three inches in the centre, thus leaving a fall for the water to run as the steam condenses; these boxes are particularly convenient for the workmen, as they turn out their work much cleaner than by the usual process, not having to attend to their charcoal fires. Another advantage is, that injury to the health of those employed is thus prevented, as every person must be convinced of the unhealthy state of rooms where charcoal is burning in open pots, without flues, from which both noxious fumes and particles of fine dust are continually escaping. Of these boxes I have introduced three only in the drawing, thinking them sufficient for explanation; but I should be very happy to attend the Society at any time to give any farther explanation that may be required. E E, I call the drums, the first I had made being of that form; it is a double cylinder of metal, with spaces of half an inch for the steam to pass through; by this means, the cylinder becomes heated, and the air passing through the centre, also becomes heated to any degree required for drying the goods. G is a vessel in which the steam from the drum E is condensed; H is a cistern, supplied with water by means of the pipe on the right hand, for the purpose of affording water by the pipe I, to the boiler; the water collected in the condenser is also discharged into the same pipe, and a stop-cock from which furnishes water to the open cistern J.

Another use to which the stove is put, is that of throwing hot dry air into the drying room, and extracting the damp air. The apparatus which performs this latter office,

Mr. Ramshaw's Apparatus for H

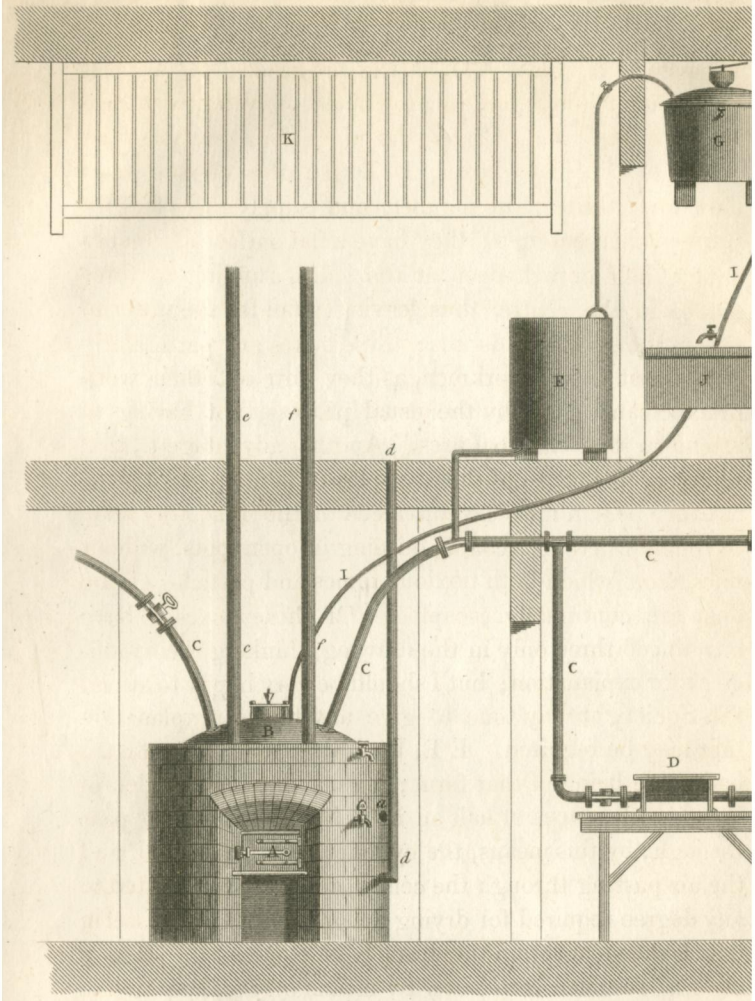


Fig. 3.

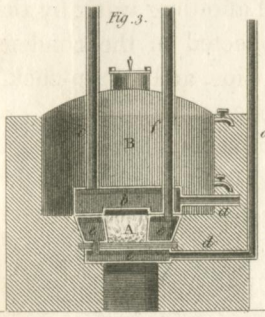
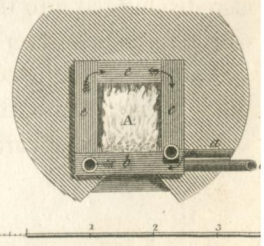


Fig. 4.



Drawn by W. Newton.

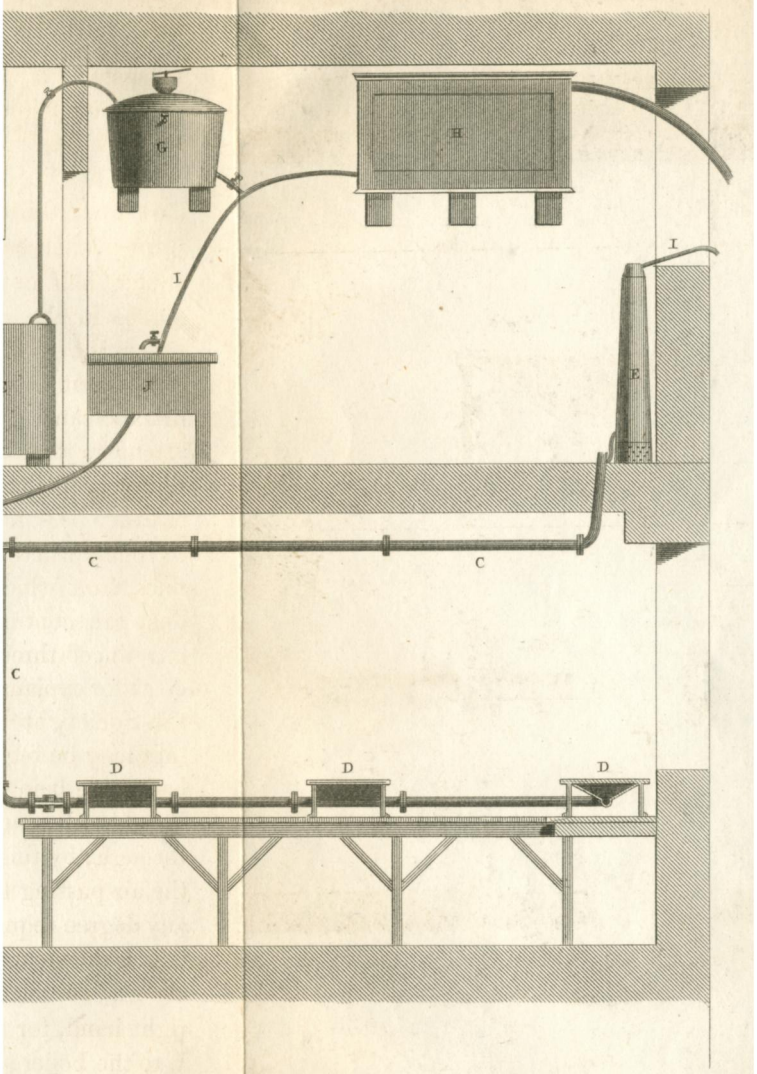


Fig. 4.

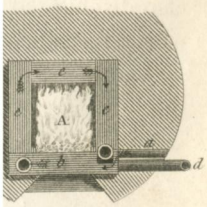


Fig. 1.

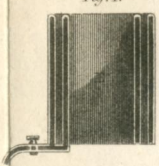
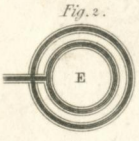


Fig. 2.



Engraved A.W.Warren.

Mr. Ramshaw's apparatus for heating Copper Plates. Pl. 7.

Fig. 5.

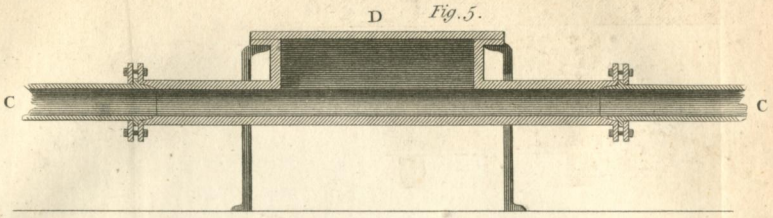


Fig. 6.

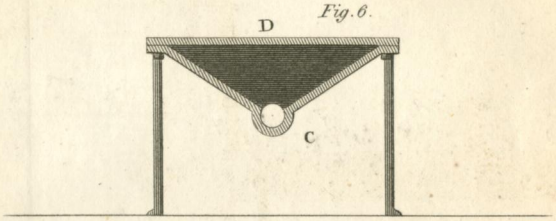


Fig. 10.

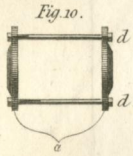


Fig. 11.

Fig. 8.

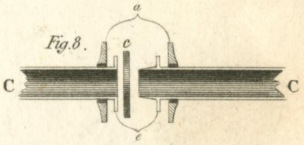


Fig. 9.

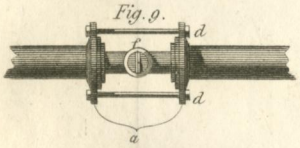


Fig. 7.

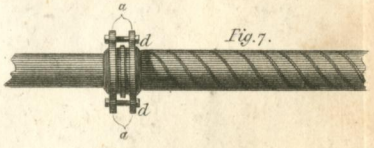


Fig. 12.

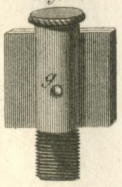


Fig. 13.

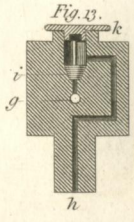
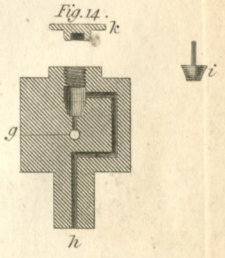


Fig. 14.



Drawn by W. Newton.

Engraved by A.W. Warren.

acts on the principle of the reversed syphon; *a*, is an open aperture in the side of the stove, fig. 3, which admits the external air into a cast iron box *b*, which surrounds the upper part of the fire: here the air being heated, passes into the drying room through the tube *c*. When cooled and saturated with moisture from the wet paper in the rack K, it falls through the tube *d* into the boxes *e e*, which surround the lower part of the fire, and being thus again heated, rises up the tube *f*, into the drying room.

Fig. 4 is a plan of the stove for the purpose of showing the boxes of cast iron surrounding the fire-place. Figs. 1 and 2 are a section and plan of the drum E.

Plate VI, fig. 5, represents a section of the heating plate D, and of the steam pipe C, to show the manner in which they are connected.

Fig. 6 is a section of the steam-box at right angles to the former section, showing the form of the box.

Figs. 7 and 8 are a view and section of the method by which two pieces of steam pipe are joined together; *c* is a washer interposed between the two shoulders, in order to prevent the escape of steam, and on the outside of the two shoulders are two flanches, through which the screws *d d*, fig. 7, pass, and thus secure the joint.

Figs. 9, 10, show the method of joining two pipes with an interposed stop-cock *f*, fig. 9. Fig. 10 shows the flanche with the hole C, through which the steam pipe passes, and the holes *e e* for the screws or bolts *d d*.

Figs. 12, 13, 14, exhibit a view and section of a valve fixed at certain distances, in the steam pipe, for the purpose of admitting the external air, when the condensation is greater than the supply.

I am, Sir,

A. Aikin, Esq.
Secretary, &c. &c.

&c. &c. &c.

JAMES RAMSHAW.

N° VIII.

PORTABLE TELEGRAPH.

The SILVER MEDAL *was this Session presented to* J. CONOLLY. *esq., Suffolk Street, Charing Cross, for a* PORTABLE TELEGRAPH, *and a printed Essay in explanation of it. A Model of the Telegraph, and a Copy of the Essay are preserved in the Society's Repository.*

MR. CONOLLY'S Telegraph is intended for land or sea service, and consists of four pieces. Three of these are square boards, *a*, *c*, *e*, fig. 1, plate IX, consisting of a black figure on a white ground, and having on the reverse of each the same figure in white on a black ground, as *b*, *d*, *f*. Each of these figures admits of being varied in four different ways by bringing each side of the square in its turn nearest to the ground. Hence each board gives eight different exhibitions, and the three boards of course give 24 exhibitions; a number amply sufficient for alphabetical communication. The other piece is a paddle shaped board, white on one side (fig. 3), and crossed by two black bands on the reverse (fig. 4) the former of these furnishes the affirmative, the latter, the negative sign.

If, instead of communicating alphabetically, a numerical vocabulary is preferred, then one of the square boards, the crescent for example (fig. 2), furnishes 8 digits, and he signals for 1 and 2, with the white paddle placed below, furnish the two other digits.

The printed essay contains a numerical vocabulary in most of the languages of Europe, consisting of 72 questions and answers, particularly adapted to the maritime merchant service.

The signal boards are 18 inches square, that size having, by experiments tried at Chatham, been found sufficient for a distance of two miles, when a telescope, with a magnifying power of 25 is made use of. Mr. Conolly has also exhibited these signals between Gros-Nez and Sarque, a distance of 17 miles; but in this case boards 12 feet square were employed.

The simplicity, cheapness, and portability of the invention, may, it is hoped, render it of use in many cases where telegraphs of a more complicated construction and less portable are not admissible, particularly in the merchant sea service, and in active military operations on shore.

N° IX.

PLUG FOR RAISING EMPTY CASKS.

The SILVER MEDAL *was this Session presented to Lieut.* W. RODGER, *R. N. for a* PLUG FOR RAISING EMPTY CASKS. *The following communications were received from him on the subject, and a Model of the Instrument is preserved in the Society's Repository.*

South Street, Sloane Square,
January 21st, 1818.

SIR;

I BEG leave to submit to the Society for the Encouragement of Arts, Manufactures, and Commerce, the model of an Expanding Plug (on a scale of half an inch to an inch of the full size) for lifting empty casks, in lieu of a hook, which is very injurious to the bung-stave.

I have already had the honour of submitting it to my Lords Commissioners of the Admiralty, who were pleased to order the guardships to be supplied with them for a trial of six months. The instrument is likewise under trial on board his Majesty's ships Semiramis and Sybille.

How far it has answered the intended purpose, will appear from the certificates I have herewith the honour to transmit.

Should the Society think the invention worthy of their notice, I shall feel much pleasure in waiting upon the Committee to give any explanation they may require.

I am, Sir,

A. Aikin, Esq.
Secretary, &c. &c.

&c. &c. &c.

WM RODGER

||

Accompanying Lieut. Rodger's letter, are copies of certificates strongly in favour of his invention, after trial of the same, sent from

P. B. PELLEW, *Captain, of H. M. S. Impregnable.*
HENRY CRACE, *Senior Lieutenant, Do.*
JOHN GAGE, *Master, Do.*
C. EKINS, *Capt. of H. M. S. Superb.*
JAMES WALKER, *Capt. of H. M. S. Northumberland.*
A. C. DICKSON, *Capt. of H. M. S. Rochfort.*
E. BOYER, *Captain of H. M. S. Queen Charlotte.*
R. WARD, *Lieut. of Do.*
T. ALEXANDER, *Capt. of H. M. S. Vengeur.*

Reference to the Figures of Lieut. RODGER'S *Plug, Plate IX.*

Figs. 5, 6, 7, 8.

a, a ring to which the rope is fastened, as shown fig. 13.

b, a bolt of a cylindrical form, but extending at its base into a cone. The ring *a*, passes through the upper part of the bolt.

c c, four segments embracing the cylindrical part of the bolt, and tied by the ring *d*, so as to keep them in their places, with regard to each other, yet to allow them (together with the cap *e*, fig. 6) to slide readily on the cylindrical part of the bolt.

To apply the instrument, grasp it by the ring *d*, and introduce it into the bung-hole, then let go the ring, and the moveable parts will slip down till they are stopped by the conical termination of the bolt. At the same time, the loose ends of the segments *c*, will be expanded, so

that on drawing the rope tight, the shoulders of these segments will be fixed on the under side of the bung stave, pressing equally all round the bung-hole, and thus preventing any injury to the stave, from the weight of the barrel while it is suspended on the rope.

Fig. 5, the instrument ready to be introduced into the barrel.

6, shows the moveable parts in a state of expansion, when they are supporting the barrel.

7, a section of the ring and bolt.

8, shows how the moveable parts arrange themselves about the conical end of the bolt.

Figs. 9, 10, a back and front view of one of the segments.

11, the ring.

12, the cap.

13, the instrument in use.

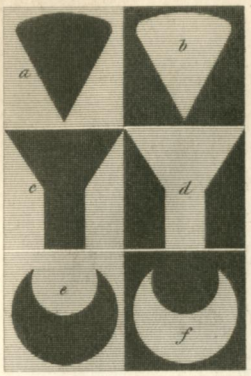


Fig. 1.

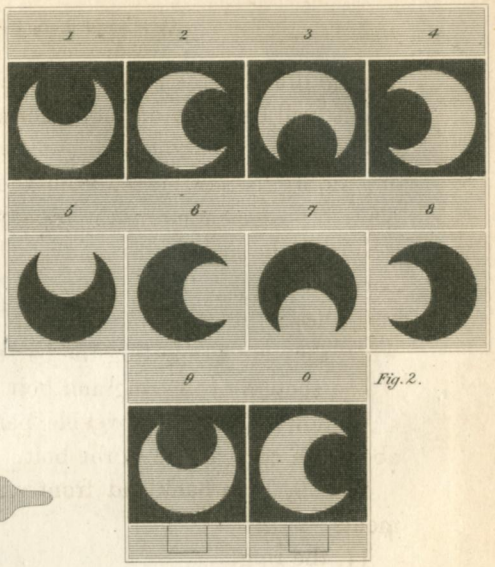


Fig. 2.

Fig. 3.

Fig. 4.

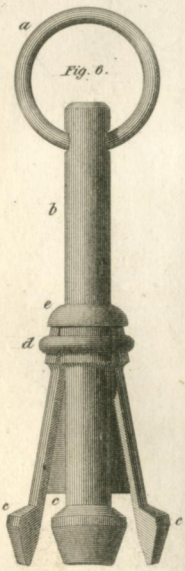


Fig. 6.

Fig. 5.

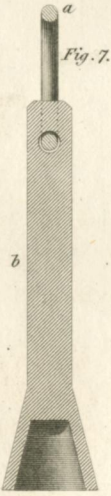


Fig. 7.

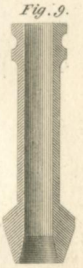


Fig. 9.

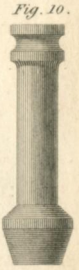


Fig. 10.

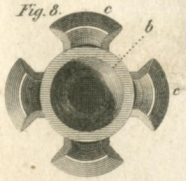


Fig. 8.

Fig. 12.

Fig. 11.

Fig. 13.

Drawn by M.A. Nicholson.

Engraved by G. Gladwin.

Lieut. Rodger's, Plug for raising empty Casks.

N° X.

IMPROVED PULLEY BLOCKS.

The SILVER MEDAL *of the Society was this Session presented to Mr.* JAMES JONES, *of No.* 150, *High Holborn, for* IMPROVED PULLEY BLOCKS. *The following communication was received from him, and Models of the Blocks are preserved in the Society's Repository.*

No. 150, High Holborn,
Feb. 11, 1818.

SIR;

HAVING effected what I conceive to be an improvement on the usual combination of Blocks, I beg leave to submit the same to the inspection of the Society for the Encouragement of Arts, Manufactures, and Commerce.

I am, Sir,

A. Aikin, Esq. &c. &c. &c.
Secretary, &c. &c. JAMES JONES.

In offering to the consideration of the Society a subject so immediately connected with the operations of many practical arts, as an improvement in the combination of tackle blocks; the extent of their application in all cases where the use of more complex machines cannot, for many reasons, be adopted, will, I trust, be sufficient apology for this communication.

The almost unlimited use of blocks (arising from their simplicity, portability, and power) is, I think, ample reason for attempting to improve an agent of so much

utility; and, indeed, the many persons who have turned their attention to the subject, sufficiently prove the importance of it.

The imperfections of common blocks are so well known to all persons who are in the habit of using them, and are, in fact, so obvious to the most cursory observer, that it would be superfluous to mention them, but that it is necessary to state the evil I would propose a remedy for. When there is more than one sheave in the same block, the fall or end of the rope to which the power is applied, comes last over the outside sheave; and that sheave, if the exertion of the power is in a line nearly parallel to the direction in which the load is drawn, always endeavours to get into a line with the point of suspension, and the place where the power is exerted. For, the great friction to be overcome, preventing the equal transmission of the power throughout the combination, and the outside sheave having to sustain, not only the pressure of its own share of the load, but the additional strain sufficient to overcome the friction of all the other parts of the blocks, and the *vis inertiæ* of the entire load; it must, therefore, be considerably depressed, and in consequence of this oblique direction of the block, the lateral friction of the sheaves becomes so great, as in some cases nearly to equal the power.

Again, if the tackle-fall is drawn in a direction, making a considerable angle with that of the load, the sheave it passes over, tends very powerfully to get into a right line with the point of suspension and the power as before; but in this case, the ill-effects are of rather a different kind; for although the block is not so much depressed on one side as in the other case, it does not face the pull; that is, the axis of the sheaves does not stand at right angles with the fall, but is considerably twisted from it, and consequently the rope suffers violent friction and wear

against the edge of the cheek of the block. And as the evils here pointed out, are rapidly increased by the extension of the combination, it is not surprising that the multiplication of pulleys thus used, soon ceases to be advantageous.

The first (and indisputably the most effectual) attempt to remove the imperfections of the common method of combination, was that of the celebrated Smeaton, who brought the fall through the middle sheave by means of double tiers; but as his arrangement does not apply to any combinations of less than twelve, as such great strains are not frequently required, and there is considerable loss of height, it is, though so perfect in itself, very seldom used.

The next was, I believe, Garnet's patent method of avoiding friction, by the introduction of friction rollers into each sheave; but this plan being expensive, soon out of repair, and not tending to remove the imperfection of lateral drag or twist by any change in the combination, did not come much into use. Then followed White's patent concentric pulleys, which, having the same tendency to drag on one side as the common blocks, laboured under the same difficulties, namely, great lateral friction and obliquity of draught; to which may be also added, a great increase of friction, arising from the speedy loss of the relative proportion of the diameters of the several grooves, occasioned by the stretch and wear of the rope. Thus, suppose we take a rope of an inch diameter, which being added to the several grooves in the top sheave (for instance) shall with its respective groove give the proportionate compound diameters of 2, 4, 6. That is a 3 inch groove, with the semi-diameter of the rope on each side is four inches; a 7 inch groove with its rope is 8 inches, and an 11 inch groove, with its rope, is 12 inches. Now, supposing the rope to stretch and wear so much as to

reduce it to 0·8 inch, the proportion of the respective compound diameters will then be 2, 4·105, 6·210, being 3·8 inches, 7·8 inches, and 11·8 inches, whereas, to preserve the just proportion, they ought to be 3·8, 7·6, and 11·4 inches, that is, as 2 : 4 :: 3·8 : 7·6, and as 2 : 6 :: 3·8 : 11·4. Thus the proportion of the grooves is entirely lost, the second one being 0·2 inch, and the third one 0·4 inch too large; and consequently in use, all the grooves except the largest both in the top and bottom blocks (for they are equally affected by the diminution of the diameter of the rope) must revolve so much slower than the rope which passes over them, as to create an immense accession of friction, thereby adding greatly to the load, and very speedily wearing out both blocks and rope. These are imperfections of such magnitude, that no one can be surprised at the discontinuance of their use. The last improvement is that of Lieut. Shuldham, and consists of White's pulley doubled, base to base, with two friction wheels in the cheeks of the block, for the axis of the compound sheave to revolve on, but on which it would be highly improper in me to make any comment whatever.

These are, I believe, the only means that have ever been proposed to improve this useful agent; and as a variety of means of effecting any particular purpose is at all times desirable to afford an opportunity of adopting that which is most applicable to the particular occasion, I trust the method I have now to propose of lessening some of its imperfections may be found sufficiently effectual to merit the attention of the Society.

Previous to describing the improvement I have adopted, it perhaps may not be deemed impertinent to mention the circumstances which gave rise to it. I had a small piece of machinery which I was desirous of keeping in motion by the action of a descending weight attached to a pair of common jack blocks, but the imperfection constantly

attendant on wind-up jacks, prevented the due effect; for the weight which, by calculation, ought to have been sufficient for the intended purpose, would scarcely keep it in motion; I therefore turned my attention to the improvement of the blocks, and adopted that shown in the model, which proved as effectual as I could wish; for the same weight with the same blocks (having undergone the necessary alteration) kept the machine in rapid motion. Having thus succeeded, I was afterwards much gratified to find that my combination was the same in effect as Smeaton's (for at the time I was engaged in the improvement, I was perfectly ignorant of the arrangement of that eminent engineer), the fall in the method I have adopted passing immediately under the point of suspension, as in his, effectually preserves the perpendicularity of position; but the transfer from the one side to the other, I have effected by the intervention of only one sheave, instead of the six (at least) employed for that purpose by Smeaton. Thus affording a means of acquiring the good effects without the necessity of employing so great a number of sheaves as the before-mentioned combination requires; and consequently rendering them simpler, and more applicable to general purposes where such great power is not frequently required.

Reference to the Engravings of Mr. J. JONES's *Blocks.*

Plate X, fig. 1, is a perspective view of a pair of iron blocks of seven sheaves, of which fig. 2 is a section, and fig. 3 is a front view of the top block.

It will be seen that the rope is tied to one of the partition plates in the bottom block at A, from whence it passes over the outside sheave at top, under the outside sheave at bottom, from whence it is transferred over to the other side by means of the cross sheave B, at

top; it then descends to the outside sheave at bottom, turns up to and over the outside sheave at top, under the centre sheave at bottom, and from thence comes out over the centre sheave at top, and consequently has no tendency either to twist or to drag on one side.

C is a thin rope or line attached to a bent wedge or gripe D, which lies on the fall in the centre sheave (as is seen more distinctly in figs. 2, 3), for the purpose of retaining the load, if the fall is let go, either by accident or design; it is evident that on the return of the fall, the wedge (if not held back by the small rope C), will be carried in by the fall, and by taking its bearing against the collet E, jam it so fast against the sheave, as to retain it in opposition to any endeavour to draw it through. The fall may be instantly released, and the load lowered by drawing the fall just sufficient to liberate the wedge, which may then be held back by the line C passing over the small roller F, and might be drawn entirely out of the block, but for the pin G inserted into the wedge, and which stops against the collet E.

Fig. 4 is a front view of a pair of wooden blocks of four sheaves (being the lowest combination of which this method is susceptible), and fig. 5 is a horizontal section of the lower block, showing the angular direction of the two sheaves, which in this case is requisite, to avoid the necessity of making the cross sheave so small as would be extremely detrimental to their action. The ellipsis seen in the view of the lower block, and the indentation in the front of the section, show the situation and form of a groove cut in the wood, for the sake of lightness.

The cross sheave in the top block is contained in a shell of metal, through which the strap passes, and thereby retains it in its proper situation, or the cross sheave may be contained in a mortise cut across the other (either at right angles or diagonally) in the same piece of wood.

Fig. 1

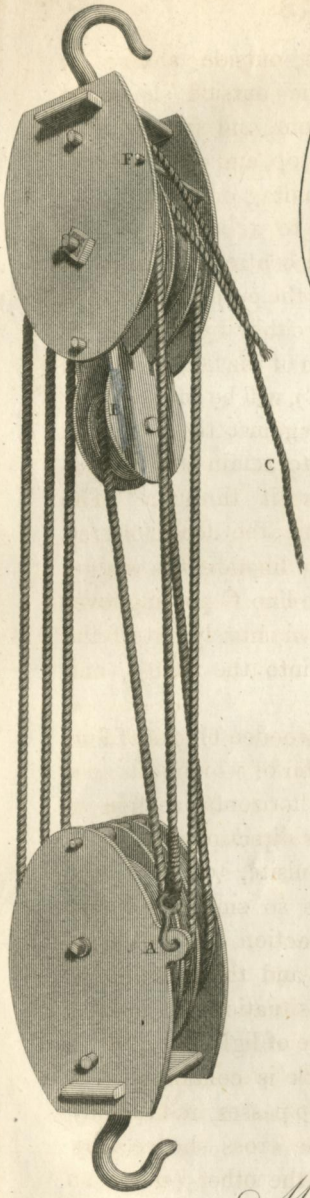


Fig. 2

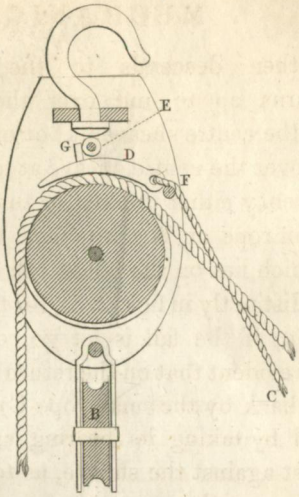


Fig. 3

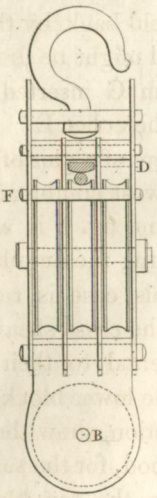
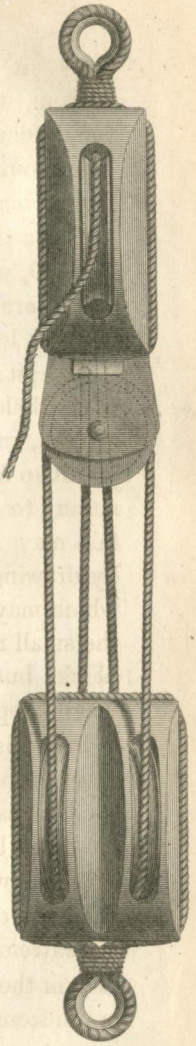
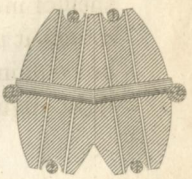


Fig. 4



Pl. 10.

Fig. 5



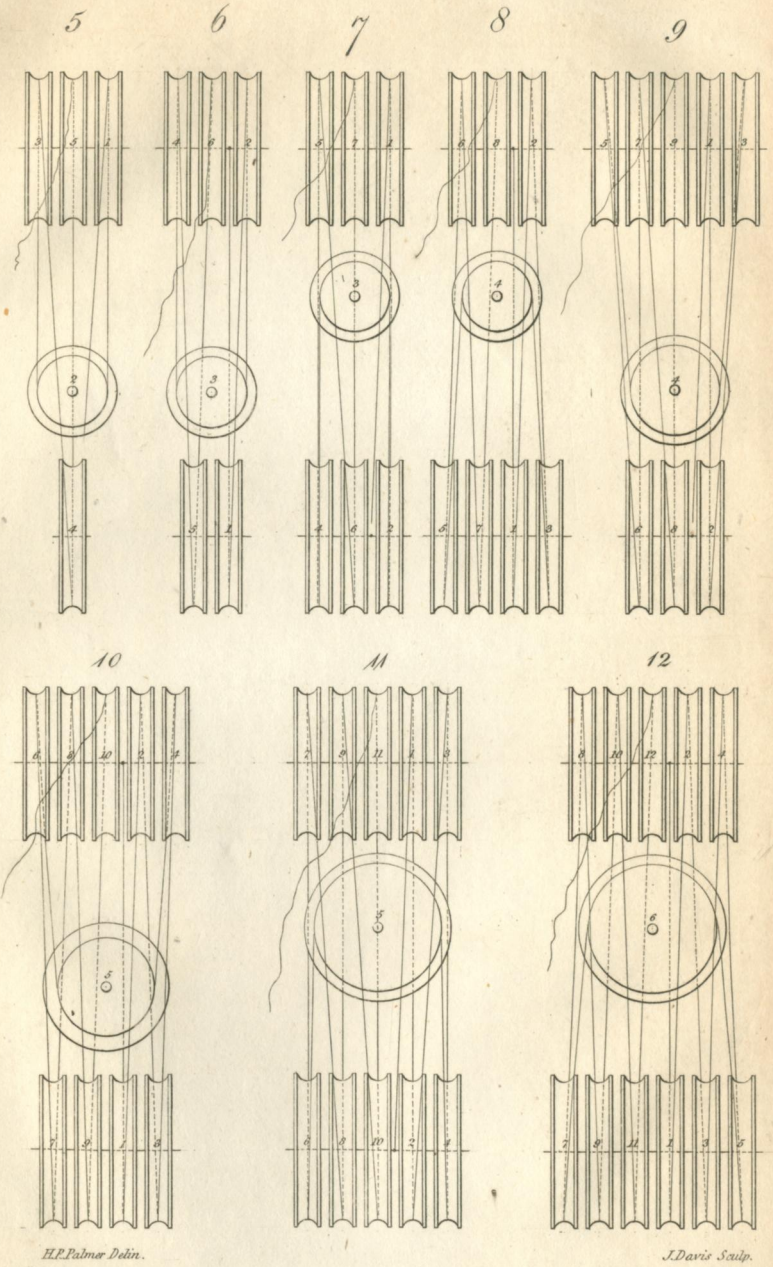
Mr. Ja.s Jones's Blocks.

Drawn by H.R. Palmer.

Engraved by James Davis.

Mr. Jones's Pulley Blocks.

Pl. II.



H.F.Palmer Delin.

J.Davis Sculp.

Plate XI is an outline of all the combinations from five sheaves to twelve inclusive; which several figures having every sheave numbered in its proper order, and the place of the tie designated by a black dot, are of themselves sufficiently explanatory.

N° XI.

TURNING LATHE.

The SILVER MEDAL *was this Session presented to Mr.* T. LANE *of Stockwell, Surrey, for improvements in the* TURNING LATHE. *The following communication was received from the Candidate on the subject; and a Model of the Machine is preserved in the Repository of the Society.*

Stockwell,
SIR; Feb. 3, 1818.

I REQUEST that you will communicate to the Society an improvement that I have recently made in the Turning-lathe. Having often occasion for one in my own business, and having experienced the imperfection of those on the usual construction, I have been led to make the following modifications, the utility of which have been amply confirmed by my own experience.

This improvement consists in making the line to run double, and in affording an easy way of regulating the pressure. Hence the line is always kept tight and ready for use, without the trouble and loss of time in tightening and slackening the line as is necessarily the case when it

runs single. The common line, unless it is strained very tight, is apt to slip on the mandril wheel, and from its tightness it causes much friction in the collar where the spindle is large, and hence runs heavy.

In my arrangement the line running double has more power on the mandril wheel without its being half so tight as ordinary, neither does it bear down on the mandril wheel, hence this latter runs remarkably light. There is indeed in my construction an additional wheel or pulley, but as it runs on two small points, it does not add materially to the friction.

I have had this in use for two years, and have every reason to be satisfied with its performance.

I am, Sir,

&c. &c. &c.

THOMAS LANE.

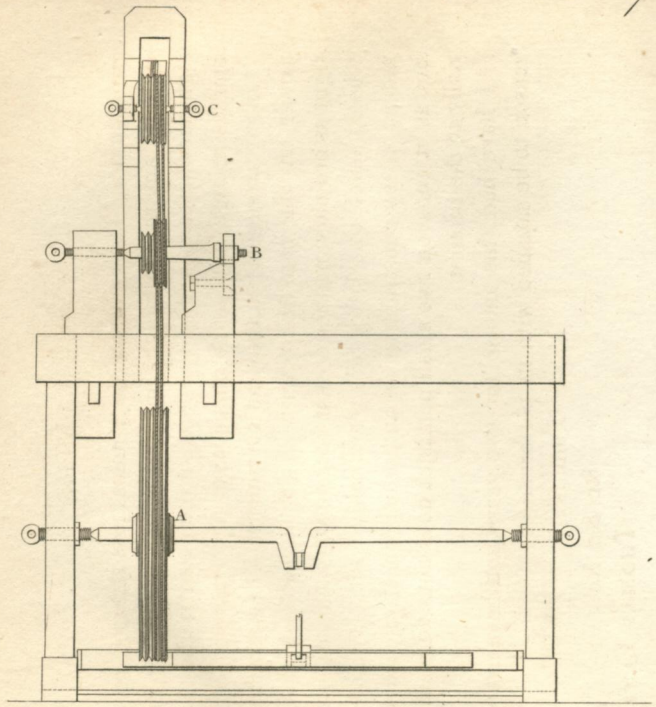
Reference to the Figures of Mr. LANE'S *Turning Lathe,— Plate XII.*

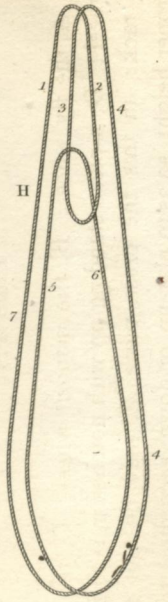
A, the fly wheel; B, the mandril wheel; C, the top wheel; D, a piece standing up with notches in it to form a rack: in this the cross piece, E, may be put to a proper height, so as to play up or down, according to the contracting or expanding of the band or line. F, the weight, the line of which runs over a small pulley G, pulling down the same, and raising the wheel C, thus keeping the band always tight.

To put the band on right, supposing one end to be at H going up at 1 over the left-hand groove of the top wheel, down at 2 under the right-hand groove of the mandril wheel B, up at 3 over the right-hand groove at C, down at 4 under the right-hand groove of the fly wheel A, up at 5

Pl. 12.

Mr. Lane's Improved Turning Lathe.





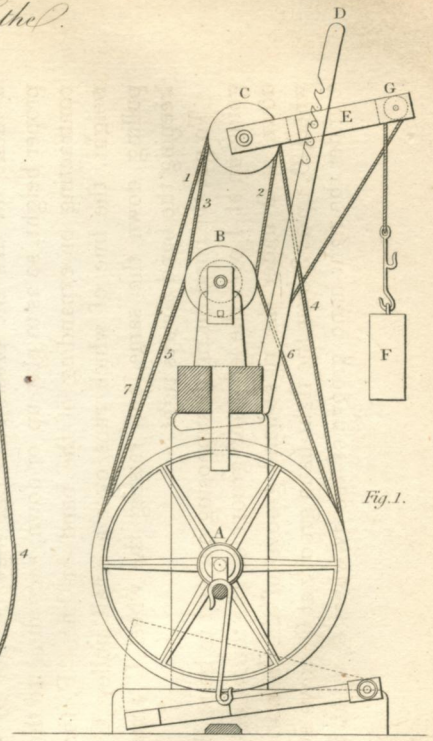


Fig. 1.

J. Clement del.

12 9 6 3 0 1 2 3 4 5 Feet

Jas. Davis, sculp.

over the left-hand groove at B, down at 6 under the right-hand groove of the wheel A, up at 7 meeting at H. The object of running the band in this way is, that it may have double power over the mandril wheel B, by going both over and under it; in the next place, the band being kept tight by the weight, it is always ready for use. There may be two or three different diameters of grooves in the mandril wheel, but it must be observed, that the two grooves which the band runs on at the same time on each wheel, must be exactly the same diameter one with the other, otherwise the band must slip and cause friction.

N° XII.

IMPROVED DOOR LOCK.

The sum of FIVE GUINEAS *was this Session presented to Mr.* MOSES SOMERFORD *of Wolverhampton, for an* IMPROVED DOOR LOCK. *The following communication was received from him on the subject, and one of his Locks is preserved in the Society's Repository.*

Temple street, Wolverhampton,
SIR; Feb. 9, 1818.

HAVING invented a new plan of working levers in Locks whereby they are rendered much more secure, and at a very little additional expense, I request that you will have the goodness to lay the same before the Society of Arts, &c. for their judgment.

It is well known that in the usual way of arranging the levers of locks, it is necessary that they should ascend to

their proper places before the bolt can pass; which arrangement gives an opportunity of introducing a nail, or a piece of stout wire, &c. into the lock, and thus raising the levers without the necessity of using the key. In the lock accompanying this letter, the arrangement has been changed, one lever being made to ascend, and the others to descend before the bolt can be shot. These works may be put into all kinds of locks without increasing their bulk, and the bolt may be made to take on one side of the lock or on the other. The lower ascending lever has an iron plate attached to it, the use of which, besides receiving the key and thus bringing it down to its central place, is, that it stands as a complete guard in front of the riding lever which descends. The lever on the top of the bolt is also of a new construction, having the lower levers working in its racks, and refusing to let them pass till it is brought to its proper position; on which account I have named it the master lever.

I am, Sir,

&c. &c. &c.

MOSES SOMERFORD.

Reference to Mr. SOMERFORD'S *Door Lock,—Plate XIII.*

Fig. 1, a front view of the lock, the upper plate being removed; *a a*, the bolt (shown separate in fig. 4) having a longitudinal perforation, in each side of which are four notches opposite each other; *b b*, a plate of brass fixed to the bolt by the pin and collet *c*, under which it freely moves (shown separate fig. 4); this plate has a perforation with four notches in the upper side, and three in the under, corresponding with the notches in the bolt, but deeper; *d d*, a spring fixed to the side of the bolt acting on the protuberance *b* of the plate *b b*, and pressing it on one side, so as to prevent the notched perforation corres-

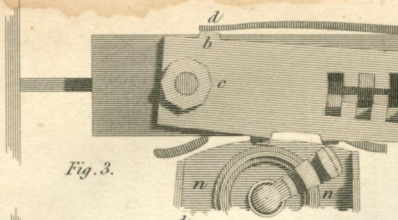


Fig. 3.

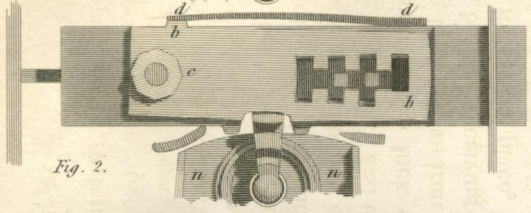


Fig. 2.

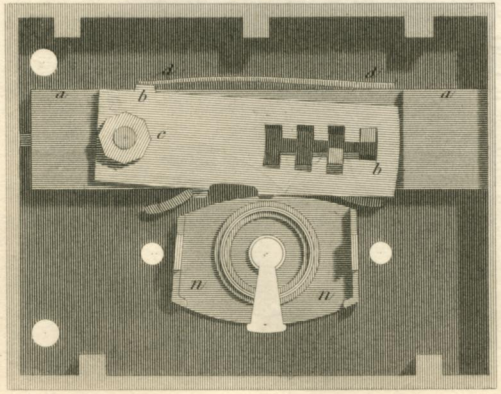


Fig. 1.

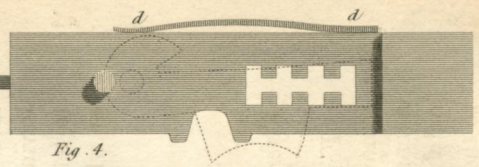


Fig. 4.

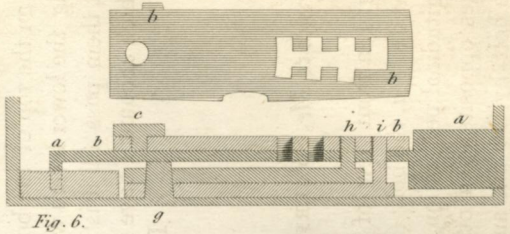


Fig. 6.

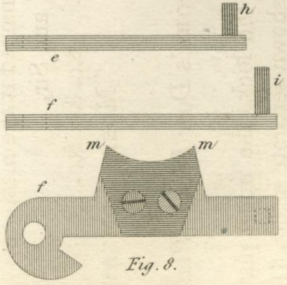


Fig. 8.

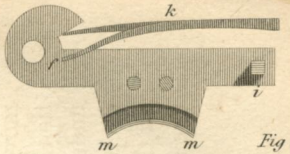
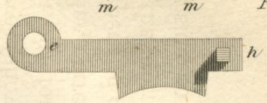


Fig. 5.



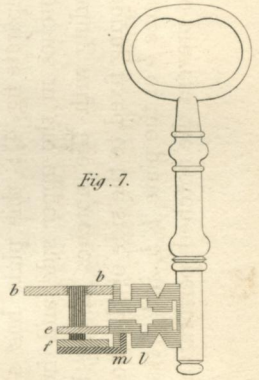


Fig. 7.

Mr. Moses Somerford's Door Lock.

Cornelius Varley del.t

Edmund Turrell sculp.t

ponding with that in the bolt. Under the bolt are two more brass plates (shown separate fig. 5), the plate *e* lying on the plate *f*; their holes *e* and *f*, go on the same pin *g*, fig. 6 (their place under the bolt is shown in fig. 4 by dotted lines); these plates carry each a square iron pin, *h* and *i*, which rise up through the perforations of the bolt, and plate *b b*. One part of a double spring *k* (fig. 5) acting on the tail of the plate *f*, keeps the pin *i* in one of the upper notches of the bolt and brass plate, while the other part of the spring pressing on the edge of the plate *e*, keeps the pin *h* in one of the lower notches of the bolt; these pins lock the bolt, and keep it from moving either backwards or forwards. Therefore to move the bolt, the key must by its hook *l* (fig. 7), travelling in the groove *m m* of the under plate *f*, pull the pin *i*, just out of the upper notch, and no more, while the front of the key pushing the second plate *e*, moves its pin *h*, just out of the bottom notch, and no more, and now the pins *i* and *h* being even, the bolt is free of them, but is locked by its upper plate *b b*, catching them in two of its upper notches; therefore the upper front of the key must raise this plate to make its perforation coincide exactly with that in the bolt, and then it is free, as fig. 2, where the key is in its place, moving the bolt. Fig. 3, the bolt advanced, the key just left it, when one pin rises into the upper notch, and the other sinks into the lower notch of the bolt, and the plate *b b* falls with one of its notches on the upper pin, by which the bolt has three securities, and these are divided by the plate *n n*, which passes through the middle of the key, two securities below and one above, and these require such an accurate fitting of the key that no other is likely to open it.

Fig. 8, the under side of the brass plate *f*, the groove *m m*, is iron, and screwed to it.

N° XIII.

IMPROVED PENDULUM.

The GOLD ISIS MEDAL *and* THIRTY GUINEAS *were this Session voted to Mr.* D. RITCHIE, *of Clerkenwell, for an* IMPROVED METHOD OF GIVING MOTION TO A PENDULUM. *The following communications were received from him on the subject, and a Model of the Invention is preserved in the Society's Repository.*

Northampton-street, Clerkenwell,
SIR; Feb. 15, 1818.

THE application of the pendulum to a clock produced at once such an accurate mensuration of time as to render it conspicuous amongst the most important and useful of modern discoveries: and the *balance* which for ages had so imperfectly pre-occupied its place, is now almost consigned to oblivion.

Although the mode of communicating motion to the pendulum of a clock appears to be very complete, yet on a strict examination it will be found to have some defects and is still susceptible of a higher degree of perfection.

Whatever may be the nature of the scapement, that contrivance may be reckoned the best which transmits to the pendulum the impulse of the wheel, with the least loss of power; but in practice, the wheel and pallets and crutch pin and pendulum rod cannot act in the same, but in parallel planes. The pendulum will therefore rather receive an oblique impulse from the crutch by its bending at each stroke, and if made stiff and strong to prevent springing, whilst it promotes it absolutely opposes the motion of the pendulum, for since the crutch pin must pass through the slit in the pendulum rod with some

shake, which will be continually increasing by *wear,* and since it can only be in contact with one side of the rod at any moment of time, it will be alternately struck by either side of the crutch pin leaping from one side of the pendulum rod to the other; thus, during the ascent of the pendulum, the lower side of the rod is impelled by the ascending side of the crutch pin, but when the pallet drops from the wheel, the crutch pin will drop on the ascending side of the pendulum rod, checking its progress, and opposing by its weight the arch of vibration.

A great part of the motive force I conceive to be dissipated in this way, but by the introduction of a new principle, I shall entirely remove this double drop and weight, and bending of the crutch, and show how it is to be effected by means of the accompanying model, which I request may be submitted to the consideration of the Society of Arts.

In this model the crutch fixed to the axis of the verge, and the suspension of the pendulum are the same as usual, but in other respects there is an essential difference: it is however absolutely necessary that the spring on which the pendulum is suspended when included in the slit of the cock should be held fast by having their surfaces firmly united. This is never well done by a pin, but effectually by means of screws, which both press the surfaces together, and prevent separation. I shall further suppose that the bar which forms the pendulum rod has its front and back sides formed into parallel planes, so that when the axis of the verge is set truly level, and the pendulum suspended, those planes may cut the axis of the verge at right angles.

To the middle of the back of the pendulum rod, and at the distance of the crutch from the line of suspension, is fastened a flat piece of rectangular steel having a part at each end bent into planes at right angles to its surface;

these ends must be equidistant, and parallel to a plane passing through the axis of the verge and the axis of the pendulum, and therefore parallel to each other. In the ends of this piece are cut rectangular notches parallel to the pendulum rod into which a hardened and tempered watch chain is fixed, and this chain should be perfectly horizontal when the pendulum is at rest; it should also be just free of the front of the pendulum rod. The steel piece has cylindric grooves cut on the outside of each end, at either extremity of the chain, which are parallel to the axis of the verge: the extreme links must be made double the thickness of the chain, by having a link riveted on each side, and the steel piece should be hardened and tempered. To put the chain in its place, press the two ends of the steel piece to approach each other, which the springing of the material will admit, and insert the chain, so that the last double outside links are found to snap into the cylindric grooves; this will secure it, and the elasticity of the piece will keep the chain in a constant state of tension; thus the whole apparatus is fixed to the pendulum, and becomes a part of it.

In the end of the crutch is fixed a rectangular prism, having a rectangular groove in it, but both the external and internal sides, must be parallel to the axis of the verge. In this groove a piece of brass is made to slide backward and forward, and may be fastened in any position, by a finger screw on its lower side. The end of this piece next the pendulum rod, is at right angles to the horizontal sides of the groove, and forms a rectangle of 2 tenths by 5 tenths of an inch. This surface must be accurately parallel to the pendulum rod, or what is the same thing, perpendicular to the axis of the verge; a prismatic cover of the same dimensions is fitted to it by two steady pins. A finger-screw, whose head is on the back of the pendulum rod, passes freely through the cover, is

screwed into the end of the slider, and its shoulder bears against the cover; a hole is cut through the pendulum rod, to clear the screw and cover, and by this screw the two surfaces are brought in contact, and by unscrewing it, the cover is raised by the exertion of a spring, inserted between the two surfaces; between these the chain already described is to pass.

The spring on which the pendulum is suspended should be of steel hardened and tempered, not more than half an inch in length, and about the same breadth, pierced out in the middle, and that part of it which bends, need not exceed the tenth of an inch. The axis of the verge if produced should pass through the plane of the spring, and should be set truly horizontal, by placing a spirit level on the two ends of the arbour made cylindrical and of equal diameters; and when the pendulum with its chain passing between the sliding piece and cover is suspended, and at rest, the effect of gravity will give it a position at right angles to the horizon and to the axis of the verge, and will also necessarily determine the front and back sides of the rod, parallel to the frame plate.

Things being thus disposed, move the sliding piece until its end comes into contact with the chain, and by means of the finger-screw beneath the piece, fasten it in that position; and, lastly, the axis of the crutch being placed in the same plane as the axis of the pendulum rod, which its gravity will nearly effect, turn the finger screw at the back of the pendulum, and clip the chain fast between the end of the slider and its cover. By these means the pallets, crutch, and pendulum are locked together, and the whole braced by a kind of rectangular framing, of which the crutch and pendulum rod, and axis of the verge and sliding piece are the opposite sides, the whole vibrating together with one uniform uninterrupted motion; and this being the case, it seems more natural to

unite, rather than separate two bodies whose motion in all respects is the same.

The double drop can no longer exist, nor the springing of the crutch, nor its weight on the pivots of the verge, for it never becomes a part, and is supported by the pendulum, whose line of suspension is without friction. This line of suspension is but a continuation of the axis of the verge, or the same right line produced; and therefore any point taken either in the crutch or pendulum rod will describe concentric circles.

This is perfect in practice in respect of the verge with cylindric pivots, and true as to perception in the pendulum, although the arch of vibration were three times greater than usual. Thus my principle is, to lock the pendulum and crutch together, which may be done without an intermediate chain, by locking the pendulum rod to the end of the slider.

After long experience in things of this nature, and in this instance having determined by actual experiment that the same arc of vibration is maintained with less power than in the usual method, I feel a confident hope, that my principle will be generally adopted.

I am, Sir,

A. Aikin, Esq. &c. &c. &c.

Secretary, &c. &c. DAVID RITCHIE.

P. S. There are belonging to this model, a thin brass bar, to be placed in the rectangular slit through which the chain passes, and another which may be conceived to be the frame plate extended, with two spikes in it, whose points are parallel to the frame plate, and just touch the chain bar. The use of these are merely to examine whether or not the pendulum vibrates in the same plane, and that the plane of vibration is parallel to the frame plate, or perpendicular to the axis of the verge, which

must take place when the surface of the chain bar during the vibration of the pendulum is in constant contact with the two points.

Reference to Mr. DAVID RITCHIE'S *Pendulum, Plate XIV.*

Fig. 1, a side view of the crutch cock and part of the pendulum bar; *a a*, the clock plate; *b*, part of the verge; *c*, the crutch; *d*, the pendulum bar having the part *e e* in the section as far as the dotted line *e e*, fig. 3; *f*, the slider and clip serving instead of the crutch pin; *g*, the slider screw; *h*, the clip screw; *i*, the grooved part of the crutch; *k*, the cover into which the screw *g* and steady pins of the slider fasten to fix it to the grooved piece of the crutch. Fig. 2, shows the part separated; *b*, the cover of the sliding clip; *m*, the spring which opens the cover when the screw *h* is loosened. Fig. 3, the back view of the pendulum bar; *n n*, the steel spring which extends the chain; *o*, the opening in the pendulum bar to make room for the slider clip and screw.

Fig. 4, a section of the pendulum bar above the spring *n*, showing a bird's eye view of the slider clip and spring *n*; *p p*, the chain extended by the spring *n n*, which the slider clip holds and attaches the crutch to the pendulum; *q q*, fig. 3, 13, and 5, the slits in the spring *n*, which receives the chain *p*; *r r*, fig. 5, the cylindric groove at the bottom of the slit into which the thickened ends of the chain *p* snaps, and is kept in its place.

Fig. 6, a front view of part of the pendulum bar showing the spring *n n*, chain *p p*, and the opening.

Fig. 7, a bird's eye view of a section of the clock plate *a a*, and pendulum bar *d*, showing a slip of brass which is laid in the slits *q q* of the spring *n n*, by the workman to know whether the pendulum vibrates parallel to the clock

plate, which is quite necessary; *t t*, two pins in another slip of brass *v v*, laid in notches *w w;* in the clock plate these pins nearly touch the slip *s s*, to show the error, if any, of the pendulum's vibrations.

The same effect may be produced by the following means, should they be preferred.

Fig. 8, *a*, represents a brass piece which is screwed to the pendulum rod, at a proper place, by two screws that pass through the screw holes *u* and *u*.

x x, represent two small steel cylinders which slide in cylindrical holes exactly in the same line as the two adjusting screws *y y*.

z, represents the end of the crutch pin held between the two cylinders *x x*, each of which is pressed firmly against the crutch pin by the screws *y y*.

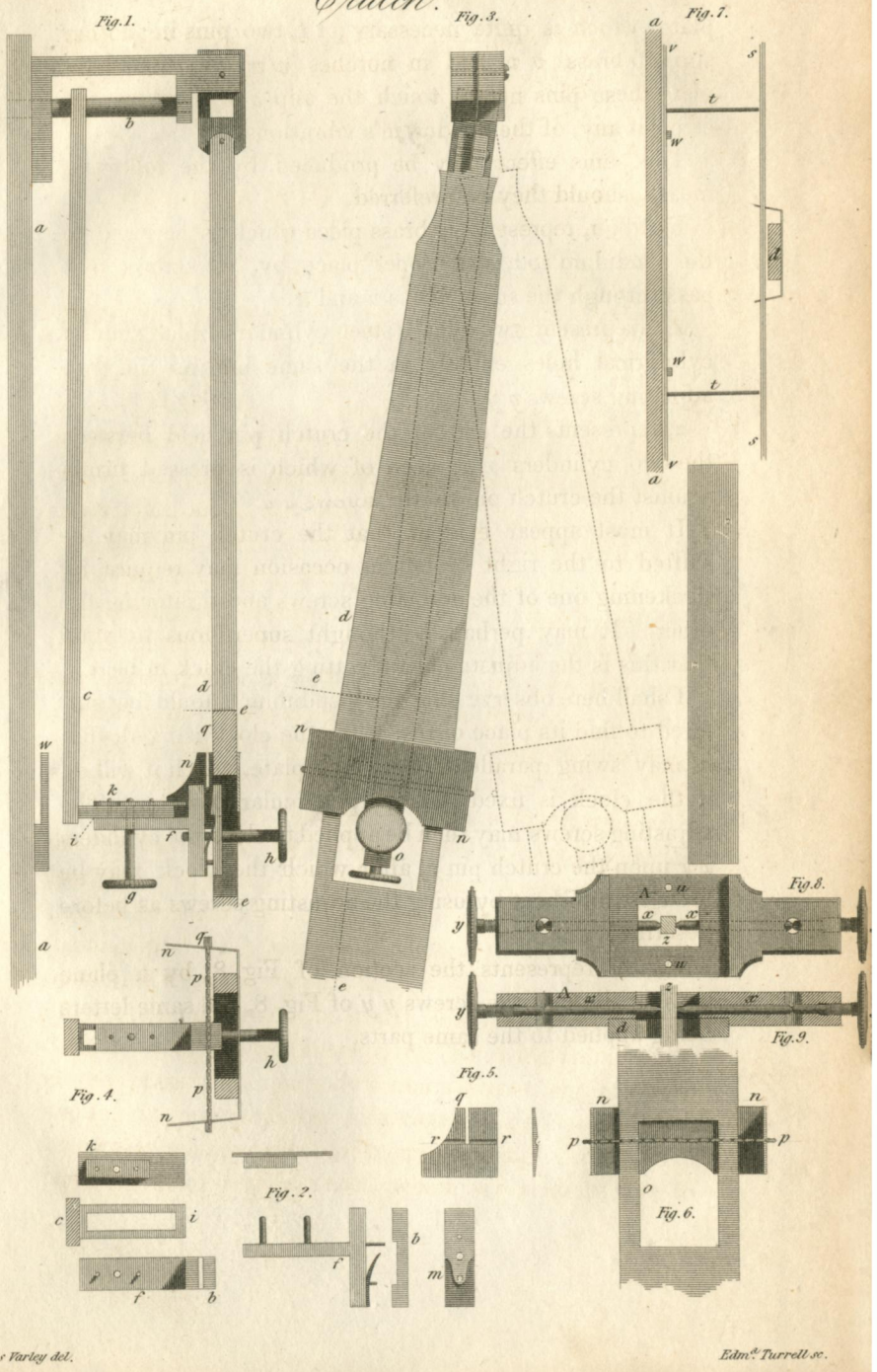
It must appear evident that the crutch pin may be shifted to the right or left as occasion may require, by slackening one of the adjusting screws and tightening the other. It may perhaps be thought superfluous to state that this is the adjustment for setting the clock in beat.

I shall here observe that the pendulum should be suffered to find its place of rest after the clock is fixed, that it may swing parallel to the clock plate, which it will do if the clock is fixed in a perpendicular position. The adjusting screws may then be applied to close the cylinders *x x* upon the crutch pin *z*, after which the clock may be brought into beat by using the adjusting screws as before described.

Fig. 9 represents the section of Fig. 8, by a plane passing through the screws *y y* of Fig. 8, the same letters being applied to the same parts.

Mr David Ritchie's Pendulum. Pl. 14.

Crutch.



Cornelius Varley del.

Edmd. Turrell sc.

N° XIV.

NIGHT LIFE BUOY.

The GOLD ISIS MEDAL *was this Session presented to Mr.* THOMAS COOK, *of Plymouth, for a* NIGHT LIFE BUOY. *The following communications were received from him on the subject, and a Model of the Invention is preserved in the Society's Repository.*

SIR;

I BEG leave to transmit through you to the Society for the Encouragement of Arts, Manufactures, and Commerce, the following account of the manner of fixing and using a Night Life-Preserving Buoy, a plan of which I had the honour of enclosing for the information and consideration of my Lords Commissioners of the Admiralty.

Captain Dacres, of his Majesty's ship Tiber, who (after the trial made by the admiral and four captains in the Harbour) had orders to try its efficacy at sea, and report thereon, wished and advised me to take this step, and (having previously written a letter to me stating his opinion, a copy of which I herewith enclose) handsomely offered to communicate any farther information respecting it, that the Society might require. Knowing from nearly eleven years experience how much something has been wanted to point out the situation of Life Buoys, when thrown to the assistance of men in the night, and also to the boats sent to their relief, which are seldom able to

find the spot even to recover the Life Buoys again, from various causes, I venture to hope that I have remedied this evil (through which many hundred lives have been lost) by the application of the composition of port-fire, as hereafter described. From among the numerous Life Buoys in use, I have selected, and with a little alteration adopted, one of the most simple, which we have the means of replacing, should that supplied be by any accident lost. This Buoy secured on two iron rods, and connected by a light chain to a spring; a piece of copper, on which the composition of port-fire is laced with wire, screwed into the perpendicular staff; and a common cannon lock, fixed in a piece of wood, placed by the head of the staff, with a copper tube, leading horizontally from the pan to the priming of the composition which contains a quick match quill tube, form the whole of the apparatus necessary for its use, so that in the event of a man falling overboard the laniard of the lock is pulled, the spring touched, and immediately a bright flame (not readily extinguished by the wash of a sea) is displayed, and points out a rendezvous for the man, and for the boat sent to his assistance.

I presume, Sir, the Society will be aware of the difficulty and improbability of finding a man in a dark night, when I state that a ship under a press of sail, when blowing fresh, frequently runs a quarter, sometimes half, and sometimes three quarters of a mile before she can round to, in order to lower a boat. But by the use of this Buoy (which on the alarm being given will be in the water a light in about five seconds, merely by pulling the laniard and touching the spring) the difficulty will be entirely removed, and the boat directed immediately to the spot.

If the plan, which is highly approved of at the India House, and by the Committee of Ship Owners, be generally adopted (and the trifling expense attending it, encourages me to hope this will be the case) seamen will

feel greater confidence in discharging such duties as necessarily expose them to the danger of falling overboard, and numbers will be restored to the service of their country, who otherwise would inevitably have had a watery grave.

I am, Sir,
&c. &c. &c.
THOMAS COOK, *Adm. Mid.*

His Majesty's ship, Tiber,
SIR; Spithead, Jan. 11, 1818.

THE Life Buoy fitted by you on board this ship having been repeatedly tried, and the manner of fixing it, and the ease with which it is let go being so very simple and superior to any I have before seen, I have great pleasure in giving my testimony in recommendation of it.

I am, Sir,
Mr. Cook, &c. &c. &c.
Midshipman, JAMES R. DACRES,
H. M. S. Rochfort. *Capt. of H. M. S. Tiber.*

The Tigris had one of the Life Buoys fitted on board by an order from the Admiralty as well as the Tiber, but was soon after paid off; the following is a copy of Capt. Henderson's letter:

His Majesty's Ship, Tigris, Portsmouth,
SIR; January 9, 1818.

HAVING had but little opportunity of trying your Life-Preserving Buoy, owing to its being so short a time on board, I do not consider myself competent to give a

decided opinion on it, but from what I have seen I think it is fitted on a most excellent plan, and does you great credit in turning your mind to so useful an invention.

I am, Sir,

Mr. T. Cook, &c. &c. &c.

H. M. S. Rochfort. R. HENDERSON, *Capt.*

Rochfort, Portsmouth Harbour,

SIR; April 16, 1818.

HAVING been an eye-witness to several experiments made by way of trial on the great utility of your new-invented Night Life Buoy, and considering its high importance for the preservation of seamen's lives to surpass any thing of the kind extant, I cannot withhold the expression of my entire approbation of its worth, to the Navy; and only wish it was more in my power to advocate its necessity generally, for I think humanity should be always prompt in devising the best means for the safety of a fellow-creature.

I am, Sir,

&c. &c. &c.

WILLIAM RICHARDSON,

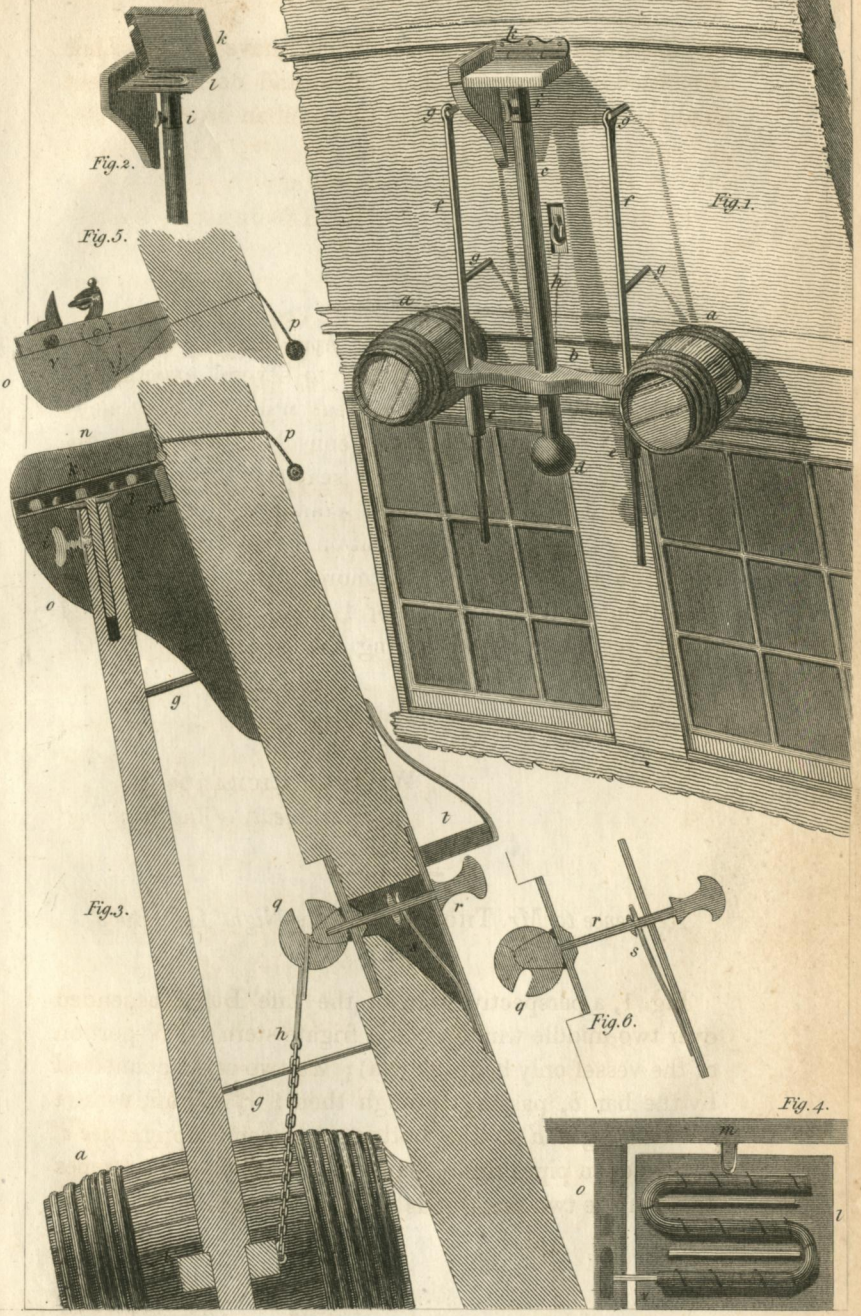
First Lieut. of the Rochfort.

Reference to Mr. THOMAS COOK'S *Night Life Buoy, Plate XV.*

Fig. 1, a perspective view of the Life Buoy suspended over two middle windows of a frigate stern (that portion of the vessel only being shown); *a a* two casks connected by the bar *b*, passing through them; *c*, a staff, with a ballast weight *d* at the bottom, to keep it upright; *e e*, two wooden pipes firmly fixed to the bar *b*; these pipes slide on the two metal rods *f f*, which are fastened to the

Mr. Thomas Cooks, Night-Life Buoy.

Pl. 15.



Drawn by C. Varley.

Engraved by A.W. Warren.

stern at *g g g g*; a chain *h* suspends the Life Buoy, and with the rods *f f* keep it tight to the stern; a copper cap is hinged to the stern at *k*; this covers the copper table which carries the port-fire, and defends it from the weather: in fig. 2 the cap is lifted up to show the table *l*; a pin is fixed under it, which goes into the staff *x*, and is fastened by the screw *i*: in figs. 3 and 4, a piece projecting from the stern, and fitting a notch in the copper table to steady the Buoy at top; *n*, a copper cap on the bracket *o*; under this cap is the lock and tube *v*, shown figs. 4 and 5; *p*, a laniard to pull the trigger; *q*, a roller with a notch for the chain *h*, to hook in *r*, a bolt which goes in a hole in the roller, and is kept there by the spring *s*; after pulling the trigger to light the port-fire, this bolt is pulled, which unlocks the roller, which turns round as fig. 6, and lets go the chain *h*; the Life Buoy then drops off the rods *f f*, into the sea; *t*, a guard to prevent the bolt being loosened by any thing falling on it. Fig. 4, a bird's eye view of the copper tablet *l*, with the port-fire laced on with wire; *o*, the bracket which holds the lock; *v*, the tube conveying the fire from the lock to the port-fire.

N° XV.

NEW METHOD OF BALLASTING VESSELS.

The SILVER MEDAL *was voted this Session to Lieut.* MOLYNEUX SHULDHAM, *R. N. for a* NEW METHOD OF BALLASTING VESSELS. *The following communications were received from him on the subject, and Models of his Invention are kept in the Society's Repository.*

34, Gloucester Street, Queen Square,
March 31, 1818.

SIR;

A PLAN of my invention, for an Improvement in the Mode of Ballasting Small Vessels, in order to increase their sailing qualities, having been tried by order of the Lords Commissioners of the Admiralty, and the result of the trial proving successful, I am induced to request you will favour me by laying the plan before the Society for the Encouragement of the Arts and Sciences, in the hope that, should they deem its merits to be such as the experience I have had of it has led me to imagine, they will, by honouring me with some mark of their approbation, be the means of drawing thereto the attention of scientific men, which may cause it to be put to farther trial.

Models of my plan (which is very simple) accompanying this letter, it will not be necessary to trespass much on the Society's time with explanation. With regard to the principle, I will merely observe, that for ages back I believe it has been known to every school-boy, who has

amused himself with sailing little boats, that they sail infinitely better with their ballast fixed to their keels: the reason of which must be obvious to every mechanic; nevertheless, to ballast sea-going vessels in the same manner, by affixing to them leaden or iron false keels, has generally been thought unsafe, as the centre of gravity would be so low as to occasion them to labour much in a sea-way, an evil certainly very great. Now, in the application of such keels, properly modified, to sea-going vessels, without being attended with the danger above-mentioned, consists the novelty of my invention; for, by an easy and convenient method of raising or lowering a certain weight of internal ballast, the centre of gravity can be altered as judgment may direct, and adapted to any state of wind or sea;—thus, a vessel may, by a vast increase of stability, obtained by the centre of gravity being low, carry more sail than otherwise; which increase in the propelling power, would cause her to sail faster in proportion to its amount; the quantity of fluid she displaces being the same: this point, being so obvious, and having been practically proved, it will not be necessary, I conceive, to enlarge on.

I must observe, that the plan is chiefly intended for vessels whose principal quality ought to be that of fast sailing; such as dispatch vessels, government vessels to cruize after smugglers, post-office packets, &c.

The enclosed copy of a report respecting a boat, built under my inspection, at his Majesty's Dock-yard at Plymouth, will fully prove to the Society how well the plan, so far, practically answered. Its success induced the Lords Commissioners of the Admiralty to order it to be tried on the Quail cutter, to which vessel, however, it did not prove so decidedly beneficial, although her sailing qualities were thereby much improved; the reason of this arises from the form and dimensions of the Quail not

being in unison with the plan, which is more suitable to a narrow vessel, and of such construction, that, without the aid of the lever of a heavy false keel, she would not have sufficient stability: such was the construction of the boat (a model of which I now present to the Society), and, had the plan been tried in a vessel of proportional dimensions to her, I can venture thus publicly to declare my belief, although with the greatest deference, that she would have outsailed, in working to windward, every vessel of her dimensions and tonnage, ballasted in the usual way, on the seas; the flying prows of the Ladrone Islands, or some other inapplicable plans perhaps excepted.

There is a model of the Quail at Plymouth Dock-yard, on a scale of an inch to a foot, which would show a still better method I have of raising and lowering the ballast, combining the advantage of the ballast lowering itself, if required, and that in a few instants: should I be able to obtain that model, I shall feel great pleasure in presenting it to the Society.*

I beg leave to enclose, besides the above-mentioned copy of report, a certificate from captain Ekins, also letters which I have received from persons who have sailed in the boat built at Plymouth, as well as from those who, from the complete success of the plan in that case, were induced to try it on their own boats.

Trusting the Society will pardon this intrusion on their valuable time,

I am, Sir,

A. Aikin, Esq. &c. &c. &c.

Secretary, &c. &c. MOLYNEUX SHULDHAM.

This model is now in the Society's Repository.

(COPY.)

Plymouth Yard,
April 21, 1817.

SIR;

SUFFICIENT trial having been now made of the boat built in this Yard under the superintendence of Lieutenant Shuldham, to ascertain her qualities in comparison with the fastest sailing boats which we could get to put in competition with her; we beg leave to acquaint you, agreeably to your minutes of the 11th February last, that two of our most eligible boats for the purpose having been tried against the said boat, the latter (Lieutenant Shuldham's) has been found much superior thereto in sailing, particularly in turning to windward against a lee-tide.

The transom of Lieutenant Shuldham's boat being raised considerably higher than those of boats in general, her body is enabled thereby to be brought down in the water for sailing without dipping the same. Boats, as commonly built, when brought down, feel an inconvenience in proportion as the transom drags in the water; and how far the boat in question, or indeed any vessel with her transom raised so high, would answer *in a sea*, and in case of getting *sternway in stays*, we cannot speak to, not having seen the boat in such a situation (the water being smooth); but we should think there would be danger in the event of the boat getting sternway, from the transom being so high, and she so lean abaft.

We observed that this boat never lost her way in stays, and being decked flush with the gunwale, and having an iron keel of considerable weight brought to her deep wooden keel, so powerful a lever is created thereby, and by the internal weight of ballast, &c. as to enable her to carry a greater proportion of sail than any other boat of similar tonnage can possibly do; nor, if the well-supported

masts stand, is there the smallest danger of her upsetting, even when having some streaks of the deck in the water.

The following is the weight of the boat, &c.:

	tons.	*cwts.*	*qrs.*	*lbs.*
Boat alone	2	2	0	12
Iron-keel, bolts, &c.	1	3	1	9
Iron ballast	1	16	0	6
Lead Do.	0	14	0	14
Men, sails, rigging, stores, &c.	1	2	0	12
Total	6	17	2	25

length in the extreme 32 feet, and 30 in keel; and extreme breadth 8 feet: tonnage, by measurement, $10\frac{84}{94}$ tons.

The plan of raising the ballast to the centre of gravity when going large, to prevent the boat from rolling, we noticed to have the desired effect, for after bearing up, when round the east end of the island, she rolled pretty quick and deep, until the ballast was raised, after which she proceeded as steadily as boats of her tonnage are accustomed to do in sailing.

But notwithstanding the great superiority this boat had over the two which were tried with her, as well as over many others which we have witnessed sailing against her, we shall submit, in order to establish a judgment in respect to the plan on which she is fitted being calculated to answer general purposes, that one of the best sailing revenue cruizers be fitted for trial against another of as nearly similar tonnage as possible, and, if possible, still better sailing qualities, although the boat in question has answered beyond expectation.

Underneath is a statement of the particulars of the sails used in the principal yard boat, and in that of Lieutenant

Shuldham's at the time of trial. Herewith you will be pleased to receive a drawing of the said boat, describing her internal fitments.

We are, Sir,

&c. &c. &c.

J. JACKSON,
W. BROWN,
A. CHURCHILL.

Lieutenant Shuldham's Boat.

Large Jib . .	$7\frac{1}{4}$	$7\frac{1}{4}$	$\left\{\begin{matrix}5\frac{1}{4}\\7\end{matrix}\right\}$	. . 23	yards of canvas.
Foresail . .	7	$8\frac{1}{3}$	$\left\{\begin{matrix}8\\6\end{matrix}\right\}$	. . $54\frac{1}{4}$	Do.
Gaff Topsail .	$7\frac{1}{4}$		$\left\{\begin{matrix}4\frac{1}{9}\\5\frac{7}{8}\end{matrix}\right\}$	. . $19\frac{1}{4}$	Do.
Mainsail . .	$6\frac{1}{3}$	$8\frac{1}{4}$	$\left\{\begin{matrix}7\frac{3}{4}\\6\end{matrix}\right\}$	. . $52\frac{1}{3}$	Do.
Gaff Topsail .	7		$\left\{\begin{matrix}4\frac{1}{2}\\5\frac{5}{6}\end{matrix}\right\}$	. . 19	Do.
Mizen . . .	$4\frac{1}{4}$	5	$\left\{\begin{matrix}4\frac{1}{6}\\3\frac{1}{4}\end{matrix}\right\}$	. . 14	Do.
			Total . . .	182	

Twelve-Oared Yard Cutter.

Jib		$24\frac{3}{4}$
Foresail		$30\frac{1}{4}$
Mainsail } Spreet		40
Mizen } Spreet		$13\frac{1}{4}$
Total		$108\frac{1}{4}$

Reference to the Engraving of Lieutenant SHULDHAM'S *Method of Ballasting Vessels, Plate XVI.*

Fig. 1, an elevation of the Quail cutter, part of the side being taken out to show the disposition of the moveable ballast.

Fig. 2, a plan of Do.

3, a section of Do.

4, a projection of Do.

a, the fixed ballast of lead or cast iron, forming part of the false keel.

b, the moveable ballast, arranged in a box or frame traversing on a screw, and thus admitting of being raised or lowered at pleasure.

c, a screw, the threads of which form a close spiral and therefore capable of being managed by the capstan bars *d*.

e, a screw, the threads of which form a loose spiral, and therefore admits of much more rapid motion than the former, but requires for its due government the addition of a cog-wheel *f*, and pinions *g g*, together with the winch *h*.

Figs. 5, 6, 7, are a section, elevation, and plan, representing one method of adapting the fixed ballast *a* to the keel, by a sliding dove-tail, parallel to the keel *k*.

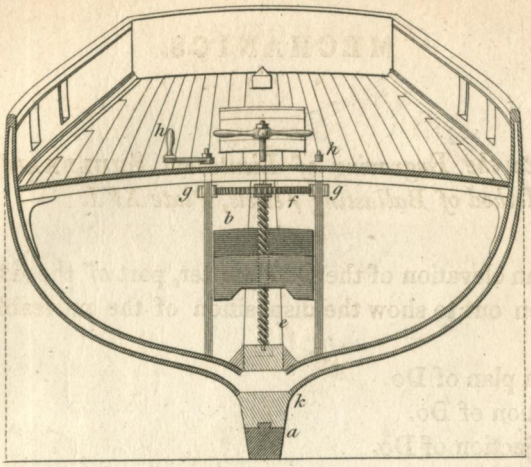
Figs. 8, 9 are a plan and elevation representing the method of fixing the ballast *a* to the keel *k*, by alternate transverse dove-tails.

Figs. 10, 11 are a plan and elevation of a mode of connecting the pieces of the fixed ballast *a* together, below the keel, to which they are afterwards fixed by vertical bolts.

Figs. 12, 13, 14, 15, plans and sections of two different forms of ballast-boxes.

Lieut:

Fig. 3.



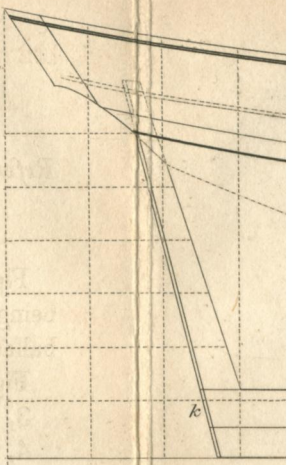
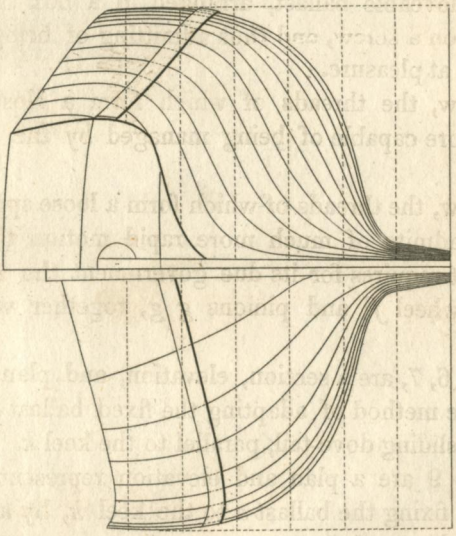


Fig. 4.



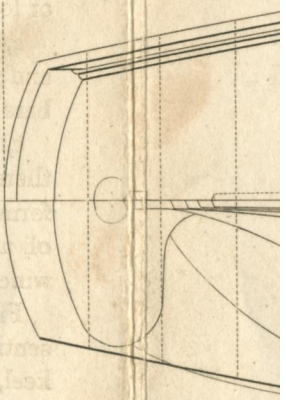


Fig. 5.

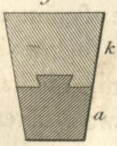


Fig. 6.

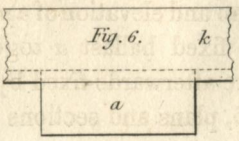


Fig. 8.

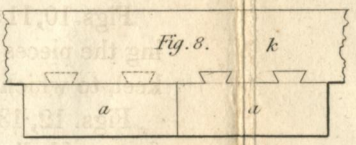


Fig. 7.

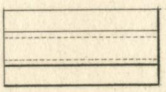
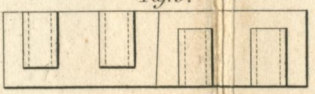


Fig. 9.



Drawn by Joseph Clement.

Lieut: Shuldham's method of ballasting Vessels.

Fig. 1.

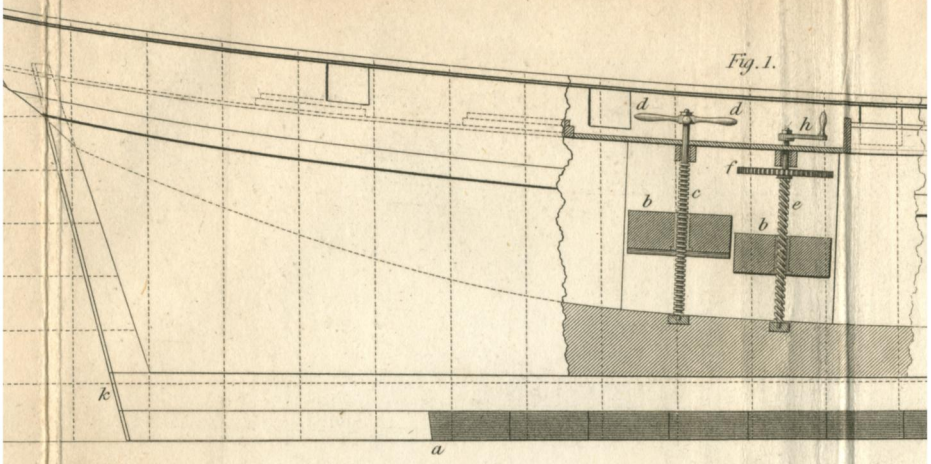
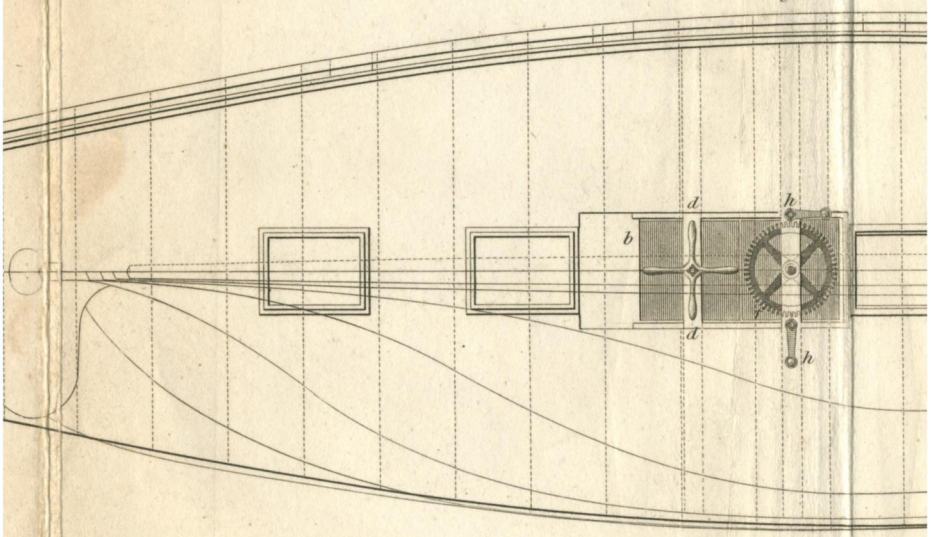


Fig. 2.



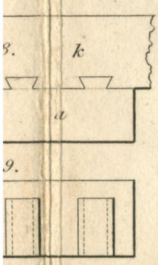


Fig. 10.

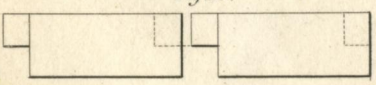
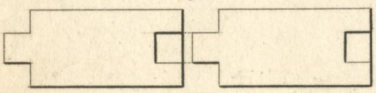
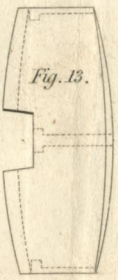


Fig. 11.





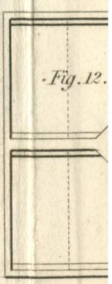


Fig. 1.

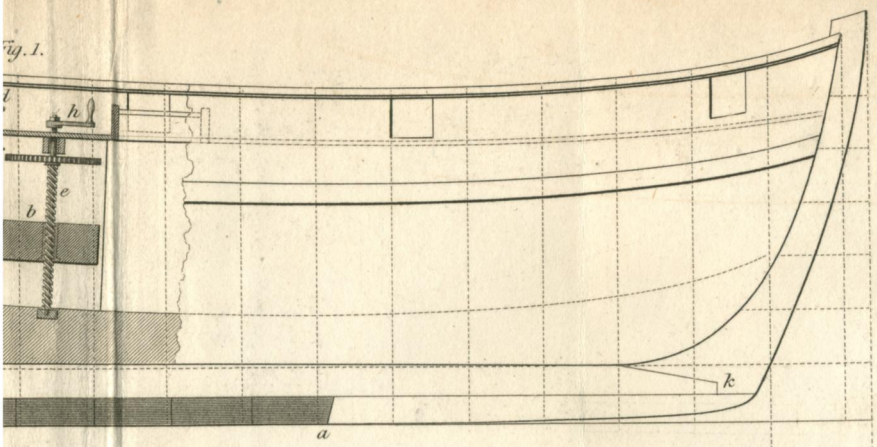
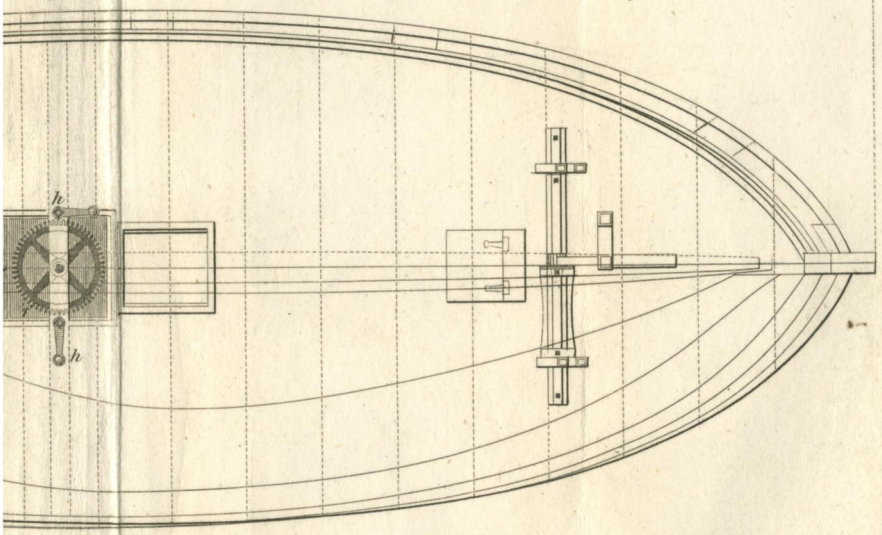
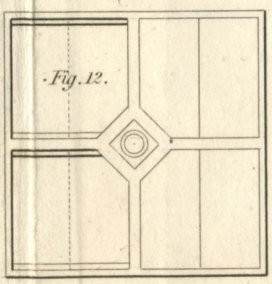
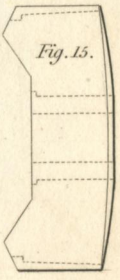
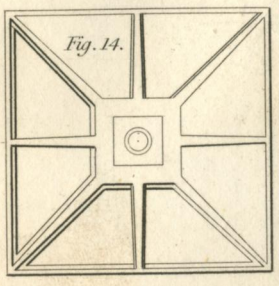


Fig. 2.









Engraved by James Davis.

N° XVI.

INSTRUMENT FOR DESCRIBING ELLIPSES.

The GOLD MEDAL *of the Society was this Session presented to Mr.* JOSEPH CLEMENT, *for his* INSTRUMENT FOR DESCRIBING ELLIPSES, *&c. The following communications have been received from him on the subject, and a Copy of the Instrument has been ordered by the Society for the purpose of being added to the collection of Models and Instruments already in their Repository.*

No. 12, Prospect Place, St. George's Fields,
January 6, 1818.

SIR;

I BEG leave, through your means, to lay before the Society of Arts, &c. an instrument of my invention, for describing Ellipses, &c. which I find exceedingly convenient in my business of a mechanical draughtsman; and thinking it might also prove beneficial to the public at large, I shall be happy in being afforded an opportunity of submitting it to the opinion of a committee of this Society (of which I have the honour to be a member), and I will attend with the instrument to explain its properties, whenever the Society may please to appoint.

I am, Sir,

A. Aikin, Esq.
Secretary, &c.

&c. &c. &c.

JOSEPH CLEMENT.

The following satisfactory testimony, from a very competent judge, of the high merit of Mr. Clement's instrument is subjoined.

No. 57, Great Titchfield Street,
DEAR SIR; Jan. 12, 1818.

I HAVE great pleasure in giving my testimony to the superiority of your Elliptical Machine: there is no one that I have seen that is so convenient in its application, or so comprehensive in its powers; and as a proof that I think so, I shall be glad to have one for my own use, notwithstanding the one of my own contrivance is universally allowed to be very perfect. Wishing you success with it,

I am, Sir,
&c. &c. &c.
W. LOWRY.

References to the Engravings of Mr. JOSEPH CLEMENT'S *Instrument for drawing Circles, Ellipses, Parallel, Radiating, and Spiral lines; the Teeth of Wheels, and the Threads of Screws; and for dividing Right Lines, Circles, and Ellipses, both geometrically and perspectively.*

This instrument is capable of describing ellipses, &c. of any possible dimensions or proportions of diameter, and in any direction or situation within the size of the instrument, as will be clearly shown by the specimens of its performance in the accompanying plates.

Plate XVII is a perspective view of the instrument without its upper dividing plate. The same letters of reference refer to the same parts of the instrument in this as well as in the succeeding plates.

Plate XVIII, fiig. 1, is a plan of the Instrument, also without the upper plate, for dividing ellipses, having a winch or handle fixed instead thereof to turn it by.

Fig. 2 is a section of the instrument, with the radial bars parallel to the lower sliding bar.

Fig. 3, a plan or bird's eye view of the instrument, with the dividing plate and index, for dividing ellipses, geometrically and perspectively.

Fig. 4 represents a front elevation of fig. 3.

Plate XIX is an elevation and section of those parts of the instrument, drawn to their full size, which could not be clearly shown on a smaller scale.

A A, is a square frame of brass, in which are fixed four pillars B B B B, having triangular holes at their upper ends, through which the two triangular bars C C, slide at right angles to each other.

In the centre of each of the bars C C is a conical hole, through the uppermost of which passes an axis, formed at one end, and on the upper side of the radial bar D, and at right angles to it (seen in the section at fig. 3, plate XIX); this axis is made a little conical, and passes through the hole in the sliding bar C, through the eye of the winch E, and is secured therein by the screw F, which adjusts the action of the joint, and by the binding screw G, which fixes it in any required position; H, a connecting piece, having a triangular hole and groove in it, through which the radial bar D, slides; and a female screw, in which the micrometer screw I, works, so as to move backwards and forwards, and retain it at any required situation; the upper part of the piece H, has a cylindrical cavity made through it, in which a cylinder fits, having a female screw in it, through which the micrometer screw I, passes, and underneath which a piece of woollen cloth is placed, lying upon the upper side of the radial bar D; this cylinder is pressed down upon the screw I, and upon the radial

bar D, by an adjusting screw J, acting in another female screw made in the upper part of the cylindrical cavity, so as to prevent any loss of time or of motion in turning the screw, and likewise to keep the radial bar steady in the angular cavity of the piece H. On the other end of the radial bar D, is fixed a piece K, having a cylindrical hole and cavity in it, to receive an axis with a shoulder on the end of the micrometer screw I, which has a pivot at its opposite end, working in a hole in the radial bar D, and a milled micrometer head L, fixed upon a short cylinder, with a steady pin or key to prevent its turning round, and secured and adjusted by means of a female nut screwed upon the end of it, which is received into a cavity made in the micrometer head L, for that purpose.

On the lower side of the connecting piece H, is a conical axis, at right angles to the radial bar D, passing through the hole in the centre of the lower sliding bar C, and into a conical hole made in the upper part of the lower connecting piece M, the lower side of which has a recess made in it, to receive a collet or washer, and which is prevented from turning round, by means of a steady pin or key; the end of the axis has also a female screw, into which a screw O, is received, which passes through, and presses upon the washer, and adjusts the proper tightness of the joint.

The lower connecting piece M, can be turned into any position upon the axis H, of the upper connecting piece, and be retained therein, by the screw O. On the under side of the lower connecting piece M, is another triangular hole and groove similar to that in the upper connecting piece H, through which the triangular bar P P slides, and furnished with a micrometer screw and milled head N, and with similar means of adjusting it as before described. On the end of the bar P P, is a piece Q, projecting downwards, having a dove-tailed groove in it, to

receive the dove-tailed slide of the socket R, which holds the drawing pen, pencil, or diamond point S for etching upon copper; this slide is furnished with two balls or weights T T, to press upon the pen, &c. On the back part of the piece Q, is fixed a spring U, the end of which is bent nearly at right-angles, and passes through a hole into the dove-tailed groove. At the back-part of the dove-tailed slide R, fig. 4, plate XIX, is a recess to receive the end of the spring U, which does not then press upon it, but permits the weights T T to act; if however the pen, &c. be raised up, it then presses upon the flat or solid part of the slide below the said recess, and prevents the pen, &c. from falling down. The cylindrical stem of the drawing pen, &c. S, is furnished with a web, which fits into a slit in the socket, to keep it steady, and prevent it from turning therein. Fig. 5, plate XIX, is a view of the upper side of the radial bar P, showing the dove-tailed groove, in which is the slide of the socket R, for holding the drawing pen, &c. Fig. 6 is a front view of the slide and socket; and fig. 7 the socket, in which can be placed a pencil or diamond point. The two micrometer screws I, and X, are made four threaded, so as to cause the radial bars D D, and P P, to move with greater velocity than can be done with single threaded screws; one turn of the screw moves the radial bar forwards one-tenth part of an inch, and the micrometer heads being also divided into ten equal parts, every division thereof is equal to the one-hundredth part of an inch; and these divisions can easily be subdivided into ten parts each, where greater accuracy is required, thus adjusting the radial bars to the one-thousandth part of an inch. Having thus described these several parts, I shall next proceed to mention the manner in which they are applied to use. When the axis at the end of the upper radial bar D D, is brought into a line with the axis of the connecting piece H, that side of the

said connecting piece, which is towards the micrometer head, will be at zero, on the scale of divisions on the radial bar D D; and the micrometer head will also stand at the zero of its scale. If the zero of the divisions on the lower radial bar P P, be then brought into contact with the same side of the lower connecting piece M, and its micrometer head also placed at zero, the drawing pen, pencil, or diamond point, will be in a line with the axis of the connecting piece H, and if the handle or winch E, be turned round, it will describe or form a point only. If the micrometer head on the screw of the lower radial bar P P, be then turned, until the two hundredth division on the radial bar is brought into contact with the side of the connecting piece M, and the handle be turned round, the pen &c. will describe a circle of four inches in diameter; or it may be made to describe any other circles, within the limits of the instrument. If, however, the micrometer head of the screw on the upper radial bar D D, be turned, until the one-hundredth division of the scale upon that bar be brought also into contact with the side of the connecting piece H, and the handle be turned round, the pen, &c. will describe an ellipsis, the longest or transverse diameter of which is four inches, and its shorter or conjugate diameter two inches, as shown at *a*, in fig. 1, plate XVIII. — All the varieties of ellipses, from a circle of four inches diameter, to a straight line, may be described by turning the micrometer head of the screw of the upper radial bar D D only, without altering that of the lower one. And whenever the sides of the connecting pieces H, and M, are brought into contact with similar divisions on the radial bars, a straight line will be drawn, on turning the handle of the instrument round.

If the lower radial bar P P, alone be successively moved within the connecting piece M, it will describe

lines parallel to any given circles or ellipses within the extent of the instrument.

The instrument having been adjusted as above described, to draw the ellipsis *a*, in fig. 1, plate XVIII, which forms one end of a short cylinder, in order to draw the sides *b b* the square frame A A is mounted upon another frame V V, and can be moved along a dove-tailed groove in the latter, by turning the milled head *v*, on the axis of a pinion, which acts in a rack, formed in the inside, and near one end of the frame V V. On the opposite end of the frame V V, is a scale, divided into fiftieth parts of an inch, to adjust the length of the straight lines, previous to drawing them; the zero of which scale coincides with the fiducial edge of the frame A A, when the latter is equally distant from each end of the frame V V, and is figured or numbered both ways, so as to show at once the eccentricity of the square frame A A, which can be fixed either concentric or eccentric, in any required position, by the two nuts *c d*, being screwed close to the stud or stop *w*; and in order to limit the action of the instrument, a screw W W, is fixed into two studs, attached to the frame A A, which passes freely through a hole in another stud *w*, affixed to the frame V V; on this screw, which has 50 threads to the inch, are two moveable nuts *c d*, each having a short cylinder upon it, the circumference of which is divided into ten equal parts, and each of these, is again subdivided into two others, making them equal to the thousandth part of an inch. Having described the ellipsis *a a*; in order to draw the two sides *b b*, of the cylinder, the square frame A A, is made concentric with the frame V V, and the nut *c*, is turned upon the screw W W, to limit the length of the sides of the intended cylinder; the square frame A A, is then at liberty to move to the right, as far as the stop or nut *c*, will permit it to do; but previous to this, the radial bars must be brought parallel to the sliding bar C C,

when the drawing pen or pencil will be at one end of the transverse diameter of the ellipsis; the milled head *v*, of the rack pinion, being then turned, will carry the square frame A A, together with the drawing pen, parallel to the side of the frame V V, to the extent limited, as aforesaid, by the nut *c*; and the straight line *b*, forming one side of the cylinder will be drawn; when, by making half a turn of the winch E, the semi-ellipsis *e e*, forming the base of the cylinder will be drawn, and the cylinder completed, by carrying the frame A A, back again to its first situation, by again turning the milled head *v*, of the rack pinion the contrary way. When a cylinder is perpendicular to the centre of the picture, the transverse axis of the ellipsis will be at right angles to the sides of the cylinder, and such as is already described; when, however, the cylinder is posited to the right or left of the centre of the picture, and cut by a plane above or below the horizontal line, the ellipsis will be more or less oblique to the sides of the cylinder, according to its distance from the centre of the picture; in order to accommodate the instrument to draw the ellipsis under these circumstances, a provision is made, by which the lower radial bar P P, can be turned upon its axis H, to any angle and retained there; thus, in order to draw the ellipsis *f f*, the lower radial bar P P, is moved to a right angle, with the upper radial bar D D, as shown by the dotted lines *g g*, when the ellipsis *f f*, may be drawn by turning the handle E, of the instrument round as before, but this ellipsis *f f*, will be made greater in both its diameters, in proportion as the ellipsis *a a*, is to the ellipsis *f f*, in consequence of the lower radial bar P P being moved to that angle with the upper one D D, and this notwithstanding the adjustments of the radial bars remain the same. By moving the lower radial bar P P, to the opposite right angle with the upper one D D, another ellipsis might be drawn, the axis of which would be at right angles to the ellipsis *f f*; if, however, it be

turned half round, or be brought parallel with the upper radial bar D D, the situation of the drawing pen will be reversed in regard to its first position, and the conjugate and transverse diameters of the ellipsis will become completely changed; the conjugate diameter will also be equal in length to the transverse diameter of the ellipsis *a a*, and its transverse diameter double thereto: nevertheless, were the lines *b b*, to be produced, the boundary lines of all these various ellipses would touch those lines, or be contained within those parallels. The two radial bars may also be moved into any intermediate positions so as to draw the ellipsis in any situation required; but when the lower radial bar is reversed to its first position, and parallel to the upper one, the properties of the micrometer screws I and X, are also changed. Thus, if the lower radial bar P P, be adjusted to describe a given circle *h h h h*, fig. 1, plate XX, then, by moving the micrometer screw I on the upper radial bar alone to different distances, so many various ellipses will be described, the conjugate axis of all which will be equal to the diameter of the circle *h h h h;* but their transverse axis may be extended to any degree within the limits of the instrument. If the length of the transverse and conjugate diameters be given, to describe an ellipsis when the instrument is in this situation, the lower radial bar P P, must first be adjusted to the conjugate diameter, and then the upper one to the transverse; but if ellipses be required to be described within the given circle *h h h h*, the lower radial bar must be turned to the first-mentioned position, and will remain equal to the radius of the circle; and the upper radial bar must be adjusted to zero; then, by screwing forward the upper radial bar, all the various ellipses may be described within the given circle, to a straight line passing through its centre, their transverse axis being all equal to the diameter of the circle.

If when the instrument is in this latter position, the lengths of the transverse and conjugate diameters of any required ellipsis be given, the lower radial bar P P, must first be adjusted to the transverse diameter, and the upper one D D, to its conjugate.

In order to render the use of the instrument more convenient, the frame V V, is mounted upon a circular, base or flat ring Y Y, the inside of which is bevelled as shown at Y Y, fig. 2, of plate XVIII, to receive four pieces *i i i i*, fig. 1, and *i i*, fig. 2, screwed to the under side of the frame V V, and capable of being so adjusted, as to make the centre of the frame V V, exactly coincide with the centre of the circle Y Y.

This circle is divided into 360 equal parts, or degrees, and these are again subdivided into 10 others, by the nonius, which is equal to 6 minutes.

Z, is the nonius, fixed to the underside of the frame V V, and can be carried round the circle Y Y, by turning the milled head *j*, of a pinion, which works into teeth, cut round the circumference of the circle.

An important application of the instrument in this state is to describing the teeth of wheels or pinions, in geometrical drawings. Thus, let the dotted line *a a*, fig. 2, plate X X, represent the bottom of the teeth of the wheel A, and the dotted line *b b*, their tops; let the lower radial bar P P, be turned half round, so as to be in a line with the upper one D D, and their micrometer heads on opposite sides of the axis; and adjust the micrometer screws I and X, to their zeros, and likewise the frame A A, to zero on the divisions on the frame V V. The instrument must then be so placed on the drawing, that the tracer point coincides with the centre of the intended wheel A; the nonius Z, must likewise be brought to its zero; the frame A A, must be moved eccentric, equal to the radius of the dotted line *a a*, and be fixed by the two

nuts *c d*, of the screw W W. The micrometer head of the lower radial bar P P, must be adjusted to the radius of the conjugate diameter of the intended semi-ellipsis, which is to form the teeth; and that of the upper one D D, to the radius of the transverse diameter of that semi-ellipsis, the number of teeth, and spaces of the intended wheel A, having been previously ascertained; the radial bars must then be brought parallel to the upper sliding bar C C; and by turning the winch or handle E, half round, the semi-ellipsis, or one tooth of the intended wheel A, will be described; then the nonius Z, must be turned, equal to the distance of the space between the bottoms of the teeth, by means of the pinion *j*; the tracer point must be slided up, and the winch brought back to its former situation; the nonius Z, must then be again turned, until the tracer point be found, when lowered, to coincide with the end of the segment, or bottom of the tooth last drawn; a second tooth may then be drawn in a similar manner with that already described, and the operation be continued until the whole be completed. In the centre of fig. 2, is described a similar wheel, but on a considerably reduced scale, in which the value of the instrument, for such operations will appear more evident.

In this manner, the teeth of the wheels in figs. 1 and 3, plate XVIII, were drawn upon the copper, by the instrument.

Another important application of it is, in describing the teeth of racks; in order to do which, the two radia. bars D D and P P, must be brought parallel to each other, with their micrometer heads on the same side of the axis, and both be adjusted to their zeros; then let the dotted line *c c*, fig. 3, plate XX, represent the bottoms of the teeth of the intended rack; and the dotted line *d d*, their tops; the tracer point must then be placed in the dotted line *c c*; and the lower sliding bar C C, must be brought parallel to the said line, by turning the pinion

head *j*; the lower radial bar must then be adjusted to the radius of the transverse axis of the semi-ellipsis *e*, or tooth of the rack; and the upper radial bar to the radius of the conjugate axis; the radial bars must then be brought parallel to the lower sliding bar C C; and by turning the handle or winch E, half way round, one tooth will be described; then, by turning the nut *d*, on the screw W W, the tracer point will be moved along the dotted line *c c*, so as to describe the space between the bottoms of two of the teeth; the size of the teeth and distance between them, having already been determined upon; the tracer point must then be lifted up, and the winch be brought to its first situation, and the nut *d*, turned, until the tracer, when put down, will coincide with the end of the said line; the instrument will then be ready for delineating another tooth; and so on, until the whole are completed; and in this manner were the rack teeth in figs. 1 and 3, of plate XVIII, also drawn upon the copper by the instrument.

It is obvious, that the tops of the teeth of either wheels, pinions, or racks, may be cut off, and made segments of circles only, or parts of straight lines, in a manner nearly similar to those of the bottoms of the teeth, when needful.

The threads of screws, or helical springs of wire, seen in perspective, can also be readily divided and drawn by this instrument, when in this latter state, with a very slight variation in its adjustments: the radial bars must first be adjusted to their zeros; then, let the dotted line *f f*, fig. 4, plate XX, represent the axis of the intended helical spring, and the tracer point be placed upon that line, and also the parallelism of the instrument be adjusted with it, as before, for the racks; let the dotted lines *g g*, represent the sides or diameter of the spring; the coils of which will appear nearly as semi-ellipses, shown more or less oblique to the sides of the spring, according

to the rake of the coils, and the situation in which they may be viewed; the lower radial bar must then be adjusted to the dotted line g, or the radius of the transverse axis $f g$, and the upper one to the radius of the conjugate axis $f h$; this upper radial bar will require continual adjustment during the progress of the operation, according to the angle in which the helical spring is viewed; and the varying obliquity or rake of the coils must be produced by turning the lower radial bar, so as to form an acute angle with the upper one; the instrument being so prepared, the tracer point must then be brought to h, or the beginning of the coil; and by turning the winch or handle half way round, the semi-ellipsis $h g i$, will be drawn. Then move the frame A A, to the right hand, equal to the distance $f j$, and screw forward the upper radial bar, till the conjugate diameter is equal to $f i$; then place the tracer at the point i, and turn the winch or handle half round, and the line $i f g$, will be drawn; then screw back the upper radial bar to its former situation, and move the frame A A, to the right hand, till the tracer coincides with the point f, and, by turning the handle half way round, another semi-ellipse, equal to $h g i$, will be drawn; and in this manner the operation must be continued, until the whole of the lines, forming the coils of the helical spring, are completed.

Fig. 5, plate XX, is a sharp threaded screw, seen in perspective, situated to the left hand of the centre of the picture, and below the horizontal line. It must be obvious to every one, that the outline of this figure will be similar to the one above described; excepting that, in consequence of its being a solid, the back part of the screw will not appear; and we have therefore only to delineate those parts of the ellipses, which are visible, forming the tops of the threads, in the manner above described.

Fig. 6, plate XX, is a geometrical elevation of a

square threaded screw. In order to describe this with the instrument, first adjust all the indexes to their several zeros; then place the instrument with its lower sliding bar parallel and perpendicular to the dotted line *a b*, or axis of the intended screw; the radial bars must then be brought parallel and perpendicular to each other, and be placed at right angles to the line *a b;* next screw forward the lower radial bar, till the tracer point coincides with *c*, or the radius of the intended screw; then turn the winch E, till the radial bars are parallel and perpendicular to the lower sliding bar, and screw forward the upper radial bar, till the conjugate diameter of the ellipsis, is equal to *d e*, or the breadth of the thread of the screw; next, place the tracer point at *d*, and draw the line *d f*, by turning the winch E, one-fourth of a circle; then move the frame A A, in the direction *a b*, equal to the distance *f g*, or the breadth of the thread, by turning the nut *d*, on the screw W W: next place the tracer point at *e*, and draw the line *e g h* (forming the lower angle of the thread); then raise up the tracer, and turn the winch E, till the tracer coincides with *i;* then put down the tracer, and draw the line *i e j*, forming the angle on the upper edge of the face of the thread; then raise the tracer, and turn it back to the point *c;* then lower the tracer, and screw forward the nut *d*, on the screw W W, to *k*, equal to the distance *c k*, or the breadth of the thread of the screw, and it will describe the right line *c k;* then turn the winch E one fourth of a circle, and the line *k l*, will be drawn; then lift up the tracer, and turn the winch E, half round, and the tracer will coincide with the point *i;* lower the tracer, and draw the line *i m*, which is similar to the line *d f*, before described; and thus proceed, until all the lines, forming the upper and lower extreme angles of the threads of the intended screw, are completed. As the interior angle of the thread is more obtuse than that of the exterior one,

part of the line, forming the interior angle, will be seen on the upper side of the thread, to the right hand of the dotted line *a b*; and part of it on the under side, to the left hand of the said line; this remains yet to be drawn; in order to do which, the frame A A, must be moved back to its first position at *c*, or to zero. In order, however, to avoid the perplexity which would arise from the letters of reference being crowded so closely together, we shall describe this part of the operation as commencing at *n*, instead of at *e*, as it would have done in the regular order of proceeding. The radial bars being brought parallel and perpendicular to the upper sliding bar; screw back the lower radial bar, till the tracer coincides with the point *o*, or the radius of the cylinder, forming the bottom of the threads of the screw; then screw back the upper radial bar, till the conjugate diameter of the ellipsis would be equal to the distance *n q*, or the breadth of the thread of the screw; then put the tracer down at the point *n*, and turn the winch E, one quarter round, and the line *n o*, will be drawn; then move the frame A A, in the direction of *a b*, equal to the distance *o p*, and the right line *o p*, forming the cylindrical bottom of one side of the thread, will be drawn; then place the tracer at the point *q*, and draw the line *q r*; then move the frame A A, back to *s*, and the line *r s*, forming the opposite side of the bottom of the thread, will be drawn; and a repetition of similar processes will complete the operation.

Fig. 7, plate XX, is a geometrical elevation of a double square threaded screw; the diameter of the screw and the breadths of the top and bottom of the threads being equal to the single threaded one, above described in fig. 6. It will be obvious, that in fig. 7, the rake or angle which the threads make with the cylinder, will be double that of the single one; and the only difference in the

operation, will be, in making the conjugate diameter of the semi-ellipsis, double to that of fig. 6.

Another important use of the instrument is, that of drawing spiral lines, in any given proportion, and whether viewed direct or oblique.

In order to describe a spiral, similar to one generated by the unwinding of a thread from a cylinder, such as is represented in plate XXI, fig. 1, the radial bars must first be adjusted to their zeros, and brought parallel and perpendicular to each other; then move them into the situation shown in plate XX, fig. 1, so as to form an angle of 45° with the sliding bars C C; the winch or handle must then be set parallel with the lower sliding bar, so as to form an angle of 30° with the radial bars.

The frame A A, and nonius Z, must also be moved to their zeros; then place the tracer point at *k*, in the centre of the dotted circle *m n*, and the lower sliding bar C C, parallel and perpendicular to the dotted line *l l*; then move the frame A A, eccentric, in the direction of the dotted line *l l*, equal to the radius of the circle *k n*, and fix it in that situation, with the two nuts *c d*, on the screw W W. Then, if the instrument were turned round by the pinion *j*, the tracer point would describe the circle *m n*, which will be equal to the end of a cylinder, by which a similar spiral or volute might be drawn, by the unwinding of a thread *n v w x*, from the cylinder; the thread being represented in eight different situations by the dotted lines, all forming tangents to the circle *m n*. The distance between the lines in each turn of the spiral, will be equal to the circumference of the circle *m n*; and the lines will all be parallel to each other. Then, after having adjusted the instrument as before described, if the tracer point be put down, it will coincide with the point *n*, which will be the beginning of the spiral. Then, lift up the tracer point,

and turn the nonius Z, round 45° towards the left hand; then turn the radial bars the same way by the winch E, 45°, or nearly parallel to the upper sliding bar C C; and screw forward the lower radial bar, till the tracer point coincides with the point *n;* then put down the tracer point, and turn the winch or handle, till it is parallel to the upper sliding bar, or 45°, and the curve line *n o*, will be drawn; then pull up the tracer point, and turn the nonius Z, 45° more; then turn back the winch E, 45°, and screw forward the lower radial bar, till the tracer point coincides with the end of the line *o;* then put down the tracer point, and turn the winch, till it is parallel to the sliding bar C C, or 45°, as before described; and the curve line *o p*, will be drawn; then pull up the tracer point, and turn the nonius Z, 45° more, and adjust the tracer point as last described, to the end of the line *p*, and draw the line *p q;* and, by repeating the operations five times more, the curve line *q r s t u v*, will be drawn, which will complete one turn of the spiral or volute; a second turn *v w*, or any number of turns, may be drawn, by continuing the said operations.

If the spiral lines be near each other, an angle of 90° may be taken, in place of 45°, and the process will be shortened one-half. Or should the line expand very rapidly, 30° may be taken, or any other lesser number.

Fig. 2, plate XXI, is a spiral similar to one generated by the unwinding of a thread from a cone. After having adjusted all the indexes of the instrument to their zeros, as described in fig. 1, and placed the tracing point at *x*, on the dotted line *d y*, and the lower sliding bar parallel and perpendicular to it, then unscrew the nut *c*, of the screw W W, to the situation as shown in fig. 1, plate XVIII, and move the frame A A, eccentric in the direction *x y*, (by making one turn of the nut *d*, on the screw W W), equal to $\frac{1}{3}$th of the space *x z;* then put down the tracer

point, and a dot will be made near the centre or axis x, on the line $x\,y$; then turn the nonius Z, 45° towards the left hand, or in the direction of the intended spiral; then move the frame A A, eccentric (by turning the nut d), $\frac{1}{8}$th more of the space $x\,z$, and put down the tracer point, and a dot will be made on the line $x\,a$ equal to $\frac{2}{8}$ths of $x\,z$; and, by repeating 14 more similar operations, two dots will be made on each line $x\,y$, $x\,a$, $x\,b$, $x\,c$, $x\,d$, $x\,e$, $x\,f$, and $x\,g$, forming two turns of a spiral, each dot being $\frac{1}{8}$th of $x\,z$, more eccentric than the other.

Then, if we suppose these dots to form the plan of a cone (x its axis), having a thread made fast at i, and wrapped twice round it in a spiral direction; if a tracer point be fixed at the other end of the thread, close to the axis x, and the thread be unwound from the cone, the volute or spiral line $x\,f$, would be generated. The same volute may easily be drawn with the compasses (on a large scale), by dividing a circle into 8 equal parts, and drawing lines from the centre through each of those divisions: set off 1 division, from a scale of equal parts from the centre, on one of these lines; then take 2 divisions, and set them off on the next line; 3, on the next; and, by continuing the operation till you have got twice round the circle, a similar set of points will be formed, to those above described by the machine; then take in your compasses an extent equal to $\frac{1}{8}$th of $x\,z$, or equal to one of the above parts; and place one point on the first dot, next to the centre x, on the line $x\,y$; and from x, describe the line x 1; then place them on the dot on the line $x\,a$, and extend them till they coincide with the end of the line 1, and describe the line 1, 2, equal to 45°; then place them on the third dot, on the line $x\,b$; and extend them, till they coincide with the end of the line 2, and describe the line 2, 3, equal to 45° more; and, by continuing similar opera-

tions, the spiral line *x*, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, will be completed; and may be continued to any number of turns, by the same process.

A spiral drawn by this rule, is not mathematically correct; but so nearly so, that the eye can scarcely perceive the difference, where the arc is not more than 45°. But should a number of lines or mouldings be required, it is impracticable to draw them by the compasses; for the centres would be so near each other, that the paper would be entirely destroyed by the point of the compasses.

On the above principle, the volutes or spiral lines, used in architecture, are drawn by the machine, and they may be drawn on a large or small scale at pleasure; and any number of lines or mouldings may be drawn, proportional to the first, as is shown in fig. 2; as no centre holes, or lines are required to be made on the paper or place where the volute is drawn. In order to do which, after having adjusted the instrument for making the spiral dots (as before described, in explaining the principle of a spiral generated from a cone,) in place of making the dot in the line *x y;* screw forwards the lower radial bar, until the tracer point coincides with the axis or centre *x;* then turn the winch E, 45° and the line *x* 1, will be drawn; then raise up the tracer point, and turn the nonius Z, 45° towards the left hand, and move the frame A A, eccentric towards the left hand (by making another turn of the nut *d,* on the screw W W), equal to $\frac{1}{8}$th more of the space *x z;* then turn back the winch 45°, and screw forwards the lower radial bar, till the tracer point coincides with the end of the line 1; then turn the winch in the direction of the spiral 45°, and the line 1, 2, will be drawn; and, by repeating this series of operations 14 times more, the spiral line *x*, 1, 2, 3, 4, 5, 6, &c. will be completed; and by the same process, any number of turns may be made, within the limits of the instrument, in proportion to the first, by

turning the nonius Z, after the first spiral line is drawn, ten or any other number of degrees, according to the distance between the two lines. If it be turned to the right hand, the line will be on the outside of the first line; and if to the left, it will be on the inside.

Fig. 1, plate XXII, is a spiral line (similar to one which would be generated by the unwinding of a thread from a cylinder), viewed obliquely. To draw a similar one by the instrument, all the indexes must be adjusted to their zeros, and the lower radial bar turned half round; then place the instrument with its sliding bar C C, parallel and perpendicular to the dotted line *b b*, with the tracer point in the center of the ellipsis *a;* then turn the radial bars, parallel to the upper sliding bar, and screw forwards the lower radial bar, till the tracer point coincides with the conjugate diameter; then turn the radial bars parallel and perpendicular to the lower sliding bar, and screw forwards the upper radial bar, till the tracer point coincides with the transverse diameter, and draw the ellipsis *a;* then see in what proportion the indexes on the radial bars are to each other. If they both stand at the same number, the process will be simple; but if the numbers vary, the use of the sliding rule, is to be preferred; for they must (in this case) bear the same proportion to each other, throughout the whole figure. In this figure, as both indexes stand at 5, screw forwards both the radial bars to 10, and unscrew the nut *c*, on the screw W W, till the frame A A, can be moved eccentric to the right hand, by turning the head of the pinion *v*, till the tracer point coincides with the end of the ellipsis *c;* then turn the winch E, half round, in the direction of the spiral, and the line *c d*, will be drawn; then screw forwards the radial bars, each 5 divisions, or to 15; and move the frame A A, towards the left hand, by turning the head of the pinion *v*, till the nut *d* stops against the stud or stop *w* (the frame A A, will then be in

its first situation); then put down the tracer point, and draw the line *d e;* then adjust the radial bars to 20, and move the frame A A, towards the right hand, till the nut *c,* stops against the stud *w,* and draw the line *e f.* It would be needless to dwell longer upon the description of this figure, as it will be easily seen, that by repeating similar operations, any number of turns may be made, within the limits of the instrument.

Fig. 2, plate XXII, is an oblique view of a spiral line, similar to one generated by the unwinding of a thread from a cone.

To prepare the instrument for this figure, all its indexes must be adjusted to their zeros, having the lower radial bar in the reversed position to the upper one, as in the last example; then place the machine on the dotted line *g h,* with its lower radial bar parallel and perpendicular to the said line, with the tracer point in the center of the figure; make a dot *i,* with the tracer point, and lift it up. Then screw back the nut *c,* on the screw W W, one turn, and move the frame A A, in the direction of the dotted line *i g,* by turning the pinion head *v,* till the nut *c,* stops against the stud *w* (the radial bars in this figure must likewise bear the same proportion to each other throughout the whole figure; for simplicity we shall again take the same number on each radial bar); then adjust the radial bars, parallel and perpendicular to the lower sliding bar C C; then screw forwards each radial bar, till the tracer point coincides with the center or dot (observing that the micrometer heads both stand at the same numbers); then turn the winch half round, and the first semi-ellipsis *i k,* will be drawn. Then unscrew the nut *d,* on the screw W W, one turn; and move the frame towards the left, by turning the pinion head *v,* till the nut *d,* stops against the stud *w;* then screw forwards the radial bars, till the tracer point coincides with the end of the line last

drawn (again observing that the micrometer heads both stand at the same number); then put down the tracer point, and turn the winch half round, and the line *k l*, will be drawn; then turn back the nut *c*, one turn, as before described, and move the frame A A, towards the right hand, till the nut *c*, stops against the stud *w*, and adjust the radial bars till the tracer point coincides with the end of the line *l*; then turn the winch half round, and the line *l m*, will be drawn; then turn back the nut *d*, one turn; and move the frame A A, towards the left hand, till the nut *d*, rests against the stud *w*; then adjust the radial bars, till the tracer point coincides with the end of the line *m*; then turn the winch half round, and the line *m n*, will be drawn. By this time, the reader will be able to understand its progression; and by continuing the same operations, a beautiful spiral will be delineated. By the same rules, spiral lines may be drawn to expand in any given proportions, and more or less oblique, from a circle to a straight line.

Another valuable application of the instrument is, to delineate geometrically or perspectively, the lines of latitude and longitude on the sphere.

Fig 1, plate XXIII, is a geometrical projection of the sphere, with its poles N. S. parallel to the plane of the picture. In order to draw the sphere in this situation, all the indexes of the instrument must first be adjusted to their zeros; then having drawn the temporary line N S, the instrument must be placed on the paper, with its upper sliding bar, parallel to, and perpendicular with, that line, or the intended axis of the sphere N S, having the tracer point in the centre of the line N S; then screw forwards the lower radial bar, to the intended diameter of the sphere; and turn the nonius Z, round 10°, and make a dot with the tracer point, upon the paper; then move it 10° more, and make another dot, and so on, at each 10°, till

the circle is completed; then screw back the nuts *c* and *d*, on the screw W W, till the frame A A, has liberty to move, equal to the diameter of the sphere; then screw back the lower radial bar, at the same time moving the frame A A, till the tracer point coincides with the first dot, or division of 10° from the pole N, or of 80°, from the equator W, and move the frame A A, towards the right hand, by the pinion head *v*, till the tracer point has reached the dot on the other side of the axis; and note down the number of the micrometer head; then take up the tracer point, and turn the winch half way round, and the tracer point will coincide with the dot at the first 80° from the equator E, on the right hand side of the pole S; then put down the tracer, and move the frame A A, towards the left hand, till the tracer arrives at the opposite dot or division, on the left side of the pole S; then lift up the tracer, and screw back the lower radial bar, at the same time moving the frame A A, as before, until the tracer coincides with the point of 70°, or the second dot from the pole S, and carry it along to the opposite point; again removing it to the opposite pole N, repeat the operation, noting down as before the number of the micrometer head, and so on successively, through each 10°, until the tracer has arrived at the equatorial line W E, which must also be drawn. Then fix the frame A A, by the nuts *c* and *d*, on the screw W W, at zero; then turn the nonius Z, half round, and set the radial bars parallel to the lower sliding bar, and axis N E, of the sphere; then screw forwards the lower radial bar, till the tracer point coincides with the end of the pole N, and turn the winch once round, which describes the circumference of the sphere, and note down the number of the micrometer head; then screw forwards the upper radial bar, till the tracer point coincides with the line at 80° from the equator; then turn the nonius Z, half way round, back again, and put down the tracer point, and turn the winch once round; and the ellipsis or

longitudinal line of 10° within the sphere will be drawn; then turn the nonius Z, back again 90°, and screw forwards the upper radial bar, till the tracer point coincides with the 70th degree of latitude; then turn the nonius Z, back to its last situation; put down the tracer point, and turn the winch round, which will describe a second ellipsis, or the longitudinal line of 20°: in the same manner all the other ellipses or lines of longitude must successively be drawn, and lastly, the straight line or axis of the sphere N S; then turn the nonius Z, 45° towards the left hand; put down the tracer point, and draw the line *e f*, the use of which will be described hereafter.

Fig. 2, plate XXIII, is another geometrical view of the sphere, with the pole N in its centre. In order to delineate this, adjust all the indexes to their zeros, and draw the temporary line *a b;* and place the instrument with its tracer point at N, in the said line, or the centre of the intended sphere, with the upper sliding bar parallel and perpendicular to that line; then screw forwards the lower radial bar, till the micrometer head stands at the number already noted down, as directed in drawing the circumference of the last figure; put the tracer point down, and turn the winch round, which will describe the circumference or equator of the intended sphere; then screw back the lower radial bar, till the micrometer head stands at the same number as noted down, when it drew the latitudinal line of 80° from the equator in fig. 1; turn the winch round, and draw the second circle, or first latitudinal line from the equator in fig. 2; then again screw back the lower radial bar, till the micrometer head stands at the same number as when the latitudinal line of 70° from the equator, in fig. 1, was drawn; turn the winch round, having first put down the tracer point, and drawn the third circle in fig. 2, or latitudinal line of 20° from the equator; and in the same manner repeat the operation, until all the latitudinal lines of fig. 2 are completed; then

screw back the lower radial bar to zero, and place the radial bars parallel and perpendicular to the upper sliding bar; then screw back the nuts *c* and *d*, on the screw W W, and move the frame A A, towards the left hand, till the tracer point coincides with the diameter of the sphere; then move the frame A A, towards the left hand, till the nut *d*, stops against the stud *w*; then put down the tracer point, and move the frame A A, towards the right hand, until the nut *c*, stops against the stud *w*, and the longitudinal line W E, will be drawn; then move the nonius Z, 10° towards the left hand; and move the frame A A, towards the left, until the nut *d*, stops against the stud *w*, as before described; and, putting down the tracer point, and moving the frame A A, towards the right hand, until the nut *c*, stops against the stud *w*, the longitudinal line of 10° from the last line, will be drawn: in the same manner, may all the remaining longitudinal lines be drawn, and the figure will be completed.

When this operation is finished, the upper radial bar will be parallel and perpendicular to the line *a b*; then turn the winch, till the radial bars are parallel and perpendicular to the lower sliding bar, and screw forwards the lower radial bar, till the tracer point coincides with the first circle or equatorial line of the sphere at W; then take the line of 45° from a sector in a pair of compasses, and set it off from the pole N to *e*, on the line N W; then screw forwards the upper radial bar, until the tracer point coincides with the point *e*; then put down the tracer point, and turn the winch round; and the ellipsis, *e a f b*, will be delineated, which is the horizontal projection of the line *e f*, in fig. 1; and the use of which we shall hereafter describe; then note down also the numbers at which the micrometer heads of the two radial bars stand.

Fig 1, plate XXIV, is a geometrical projection of a sphere, with its axis elevated at an angle of 45° to the plane of the picture. All the lines of longitude and latitude in

this situation of the sphere, will become ellipses, excepting the right line, which passes through its centre; and in order to delineate them with the instrument, first find the situations of the transverse axis of the ellipsis, which form the longitudinal lines; which will be done by drawing the line *e f*, fig. 1, plate XXIII, or the ellipsis *e a f b*, fig. 2, which will be parallel to the plane of the intended sphere or picture, when the pole is elevated 45°, and will cut the longitudinal lines at its greatest extremity, which will be the transverse axis of the required ellipsis; then take the radius of the sphere in a pair of compasses, and extend the line of sines upon a sector, till the points of the compasses coincide with 90°; then place one leg of the compasses in the centre of the sphere, fig. 1, plate XXIII, and extend them along the line *e* to the first intersection at *e* of the longitudinal line of 80°, and apply that opening to the sector, which will be equal to 14°; then, extend the compasses to the second intersection, at *u*, of the longitudinal line of 70°, which will be found, by applying to the sector, to be 27·2°; then extend the compasses to the intersection at *s*, of the third longitudinal line of 60°, which will be found in the same manner, to be equal to 39·25°, and thus proceed till all the intersections of the longitudinal lines are measured, which will be equal to the following numbers, viz.:

Degrees of Longitude.				Degrees from the centre of the sphere to the intersection of the longitudinal lines, with that of the right line *e f*.
	90	=	0	
w,	80	=	14°	
u,	70	=	27·2	
s,	60	=	39·25	
q,	50	=	49·9	
o,	40	=	59·3	
m,	30	=	67·8	
k,	20	=	75·56	
h,	10	=	82·9	
	0	=	90	

As, however, this mode of finding the transverse axis of the longitudinal ellipsis, is difficult to effect, as we approach towards the circumference of the sphere; it is necessary to proceed in another manner to find the transverse axis of those ellipses, and which will be more accurate in those parts where the first method is deficient, although it is less so in others where the first mode is perfect, and we shall thus attain an equal degree of perfection throughout the whole; in order to which the ellipsis *e a f b*, fig. 2, plate XXIII, has been prepared; then where the ellipsis intercepts the radial or longitudinal lines, through these points draw lines, *g h*, *i k*, *l m*, &c. parallel to the line W *e*, from the intersections to the circumference of the sphere; which will cut the arc W *b*, of the sphere, in the same number of degrees from 90°, as in the former operation; then take the radius of the sphere in a pair of compasses, and extend the sector till 60° on the line of chords coincides with that distance; then place one leg of the compasses at the longitudinal point 90°, and extend the other to the point *v*, where the parallel line *v w*, cuts the circumference of the sphere; and apply that distance to the line of chords on the sector, which will be found equal to 14°: in like manner measure the arc from 90° to *t*, which will be found equal to 27·2, as will also the arc from 90° to *r*, be equal to 39·25, and so on through the remaining points *p*, *n*, *l*, *i*, *g*, and W, which will all be found to correspond with those in the above table.

By a similar process, the transverse axis of the longitudinal ellipsis may be found for any other elevation of the poles. They may also be obtained by means of logarithms. After having found the positions of the transverse axis of the longitudinal ellipses, as before described, we shall now proceed to point out the manner of finding the lengths of the conjugate axis; in order to accomplish

which, we must first be prepared with a scale of equal parts, to correspond with the divisions on the radial bars of the instrument, each of which is equal to the 1000th part of an inch; then with a pair of compasses take the radius N *f*, of the conjugate diameter of the ellipsis *e*, *a*, *f*, *b*, fig. 2, plate XXIII, which will be equal to the distance of the poles from the centre of the intended sphere, and extend the line of sines on the sector until 90° coincides with that distance; then subtract the sine of 90° from the radius of the sphere, and the remainder will be the number that the upper radial bar must be adjusted to.

It will now be necessary to construct a table of the numbers on the radial bars, and the degrees corresponding with the transverse diameters on the circular plate of the instrument Y Y, as follows:

For example: let the radius of the sphere be equal to 2,000, or 2 inches; then the radius of the conjugate diameter of the ellipsis *e a f b*, equal to 1405, being subtracted from 2,000; there will remain 595, which will be the first number on the upper radial bar; then take 80° in the compasses from the line of sines on the sector, which, applied to the scale of equal parts, will be found to be 1383; this number being also subtracted from 2,000 there will remain 617, which will be the second number to be found on the upper radial bar.

In like manner must numbers be found corresponding to the remaining degrees, and the whole arranged in a tabular form, thus:

Positions of the Transverse Axis, in Degrees on the Circular Plate Y Y, or the Nonius Z.	Numbers on the Lower Radial Bar.	Numbers on the Upper Radial Bar.
0	2·000	59·5
14°	2·000	61·7
27·2	2·000	68·1
39·25	2·000	78·6
49·9	2·000	92·5
59·3	2·000	109·7
67·8	2·000	129·8
75·56	2·000	152·0
82·9	2·000	175·5
90·	2·000	2·000

Fig. 2, plate XXIV, represents the lines of longitude of the above sphere, consisting of a right line *k k*, passing through the poles, and a series of ellipses, the transverse axes of all which are equal to the right line *k k*, or diameter of the sphere; then, in order to delineate this figure, the instrument must first have all its indexes adjusted to their zeros; then place the lower sliding bar parallel and perpendicular to the assumed right line *k k*, and the tracer point in the centre of that line; then screw forwards the lower radial bar, until the tracer point coincides with the diameter of the sphere; for example, say at the division of 2,000 on the radial bar, equal to two inches, or the radius of the intended sphere; then screw forwards the upper radial bar as above described, which will be equal to 59·5, as in the before-mentioned table, namely, to the division of 5 on the radial bar, and 9·5 of the micrometer head on the screw of that bar; then put down the tracer point, and turn round the winch, and the ellipsis *a a*,

or that having the greatest conjugate diameter, will be drawn, and which answers also for the equatorial line, and is indeed similar to that already drawn in fig. 2, plate XXIII; then turn the nonius Z to 14° towards the right hand, and screw forwards the upper radial bar to 61·7, namely, to the 6th division on the bar, and to 1·7 on the micrometer head of that bar; and having put down the tracer point, and turned the winch once round, the second ellipsis *b b*, will be drawn; the nonius Z must then be turned backwards 14° towards the left hand from zero; and the tracer point being put down by turning the winch round, the ellipsis 1 1, will be drawn, which will be similar to the ellipsis *b b*, already drawn; next turn the nonius Z towards the left hand, to 27·2°, and screw forwards the upper radial bar to 68·1°, and describe the ellipsis 2 2, also carry the nonius to 27·2° on the right hand of zero, and describe the ellipsis *c c*, and by continuing similar operations, and taking the succeeding numbers as they stand in the table, may all the other ellipses of that figure be delineated.

Having thus described all the ellipses forming the longitudinal lines of the intended sphere, the next step necessary will be, to point out the manner of finding the transverse and conjugate diameters of the ellipses, forming the latitudinal lines; the length of the transverse axes will be equal to the length of the latitudinal or straight lines in fig. 1, plate XXIII: if we then take half the length of any one of these lines in a pair of compasses, and apply it to the scale of equal parts before described, a number will be found which, when transferred to the divisions on the lower radial bar, will be the radius of the transverse diameter of one of the intended ellipses, or equal to the radius of one of the circles in fig. 2, plate XXIII: for example, let us take half the length of the line extending from 80° to 80° in fig. 1, plate XXIII, which will be equal to

346, on the scale of equal parts; then screw forwards the lower radial bar to that number. To find the conjugate diameters, project lines at right angles to the line *e f*, from each extremity of the latitudinal lines; for example, that from 80° to 80°, the distance between which will be equal to 240, which number, being subtracted from 346, there will remain 106; the upper radial bar must be then screwed forwards to that division, and the instrument will be prepared for drawing the two smallest ellipses in fig. 1, plate XXIV, or the latitudinal lines at 80° from the equator; in order to do which the nonius Z, must remain at zero, as when the first ellipsis *a a*, fig. 2, was drawn; then, with a pair of compasses, take the distance from 90° to 80° on the line *e f*, fig. 1, plate XXIII, and set it off from both the poles, towards the centre of the intended sphere, fig. 1, plate XXIV: then unscrew the nuts *c* and *d* on the screw W W, till the frame A A, can pass either to the right or left of its zero, or till the tracer point coincides with the division last set off with the compasses, from the poles on the right line, fig. 1, plate XXIV; turn the winch round, and one of the smallest ellipses will be drawn; then, observe the number on the scale V V, that the fiducial edge of the frame A A, stands at on that scale, and move the frame A A, to the same number on the other side of the zero of that scale, and the point of the tracer will coincide with the distance set off with the compasses, and the ellipsis which surrounds the other pole may be drawn.

In like manner the ellipses which form the remaining latitudinal lines may be found and delineated; but the extremities of the transverse and conjugate diameters of the ellipses forming the latitudinal lines will be more readily and accurately found by the use of the additionalor upper dividing plate 2, fig. 3, plate XVIII, which will be hereafter described. When all the longitudinal lines are completed, and the instrument adjusted to drawn the right line *k k*, then

place the radial bars perpendicular to the said line, and the commencement of the divisions on the dividing plate will coincide with the index 7 7; then adjust the index to that circle of divisions upon the plate 2, which is divided into 360°, and turn the dividing plate 5°, and make a dot with the tracer point on the line *k k*; then turn the dividing plate, and make a dot at every 10° till it has been turned half round, when a sufficient number of dots will be made, which will be the conjugate diameters of the ellipses on each side of the pole, or the latitudinal lines. The transverse diameters of the above ellipses may be found by a similar process to the above; the only difference is, to commence with turning the dividing plate 10° in place of 5°, and when completed it will be similar to a line of sines of 10° between each dot.

But the transverse diameters are already limited, as will be seen by the inspection of fig. 1, plate XXIV, which will be at the same points that the longitudinal lines intersect the equator.

We shall next proceed to describe the additional dividing plate and index, for dividing ellipses, geometrically and perspectively.

Fig. 3, plate XVIII, is a plan of the instrument in the operation of dividing an ellipsis geometrically, or as it would be divided by describing a circle around it, equal in diameter to its transverse axis, and dividing this circle into any number of equal parts; these divisions are transferred to the included ellipsis, by drawing lines parallel to the conjugate diameter of the ellipsis through each division of the circle, until they meet the ellipsis. Geometricians, however, find this method of dividing ellipses exceedingly difficult in practice, when their conjugate diameters differ considerably from their transverse diameters; or, when the ellipses approach near to a straight line.

To prepare the instrument for this operation, the winch or handle E, must be removed, and the circular frame 1 1,

&c. on which the additional dividing plate 2 2, is fixed, must be placed in its stead, and retained in the required situation, by means of the adjusting screw F, and the binding screw G: the toothed wheel 1 1, has three arms, and a number of flat rings round it, for the sake of lightness, and which also serve to support the dividing plate 2 2; the dividing plate is fixed to the wheel, by means of two screws passing through the grooves 3 3, in the opposite sides of the wheel, and screwing into square bosses formed in the under side of the dividing plate; under the head of each screw, is a thin spring or washer, which permits the bosses in the dividing plate to slide along the grooves 3 3, but affords sufficient friction to retain it in any required degree of eccentricity. The slide of one of the grooves 3 3, is divided into a scale of equal parts, and a tongue, or sliding piece fitted into the groove, and attached to the dividing plate, has a nonius upon it, for adjusting the eccentricity of the plate, when dividing an ellipsis perspectively; but when, as in the present instance, it is used for dividing the ellipsis geometrically, it must be fixed at zero, or concentric with the axis on which the wheel 1 1, is fixed. A short pillar, having a triangular hole through it, is firmly screwed to the end of the upper sliding bar C C; to this pillar two short arms are fixed, which support the axis of a pinion 5, which works in the teeth of the wheel 1 1, and has a winch or handle 6, to turn it; by this means the dividing plate can be moved and retained more accurately than by moving the wheel 1 1, by the hand. Through the upper end of the pillar 4, is another triangular hole, parallel to the lower one, through which passes the stem of an index 7 7, which can be fixed by a binding screw, in any required position; one edge of this index must be perpendicular to the centre of the upper sliding bar C C, and form a radial line to the axis of the wheel 1 1, and must also be bevilled to a thin fiducial edge, and have a line or mark in the middle of it; which line

may be adjusted to any of the circles of divisions upon the plate 2 2, by means of its binding screw, and serves to show that circle which is in use. The circles may be divided into any numbers which can be most readily subdivided by others; I have chosen the following, viz. 660, 600, 510, 390, 384, 360, 342, 336, 324, and 276; and for convenience in using the instrument, I have arranged the numbers, and those by which they can be subdivided, into a tabular form as follows, viz.:

2 × 180 = 360	36 × 9 = 324	110 × 6 = 660
3 × 120 = 360	38 × 9 = 342	112 × 3 = 336
4 × 90 = 360	39 × 10 = 390	114 × 3 = 342
5 × 72 = 360	40 × 9 = 360	120 × 3 = 360
6 × 60 = 360	42 × 8 = 336	128 × 3 = 384
7 × 48 = 336	44 × 15 = 660	130 × 3 = 390
8 × 45 = 360	45 × 8 = 360	132 × 5 = 660
9 × 40 = 360	46 × 6 = 276	138 × 2 = 276
10 × 66 = 660	48 × 7 = 336	150 × 4 = 600
11 × 60 = 660	50 × 12 = 600	162 × 2 = 324
12 × 55 = 660	51 × 10 = 510	165 × 4 = 660
13 × 30 = 390	54 × 6 = 324	168 × 2 = 336
14 × 24 = 336	55 × 12 = 660	170 × 3 = 510
15 × 24 = 360	56 × 6 = 336	171 × 2 = 342
16 × 21 = 336	57 × 6 = 342	180 × 2 = 360
17 × 30 = 510	60 × 6 = 360	192 × 2 = 384
18 × 19 = 342	64 × 6 = 384	195 × 2 = 390
19 × 18 = 342	65 × 6 = 390	200 × 3 = 600
20 × 18 = 360	66 × 10 = 660	220 × 3 = 660
21 × 16 = 336	69 × 4 = 276	255 × 2 = 510
22 × 30 = 660	72 × 5 = 360	276
23 × 12 = 276	75 × 8 = 600	300 × 2 = 600
24 × 14 = 336	78 × 5 = 390	324
25 × 24 = 600	81 × 4 = 324	330 × 2 = 660
26 × 15 = 390	84 × 4 = 336	336
27 × 12 = 324	85 × 6 = 510	342
28 × 12 = 336	90 × 4 = 360	360
30 × 12 = 360	92 × 3 = 276	384
32 × 12 = 384	96 × 4 = 384	390
33 × 20 = 660	100 × 6 = 600	510
34 × 15 = 510	102 × 5 = 510	600
	108 × 3 = 324	660

The first of the three columns in this table points out numerically all the numbers, from the lowest to the highest, which can be obtained from this set of numbers; and the second column is the number which multiplied by the first, will be equal to the number in the third, which will be found upon the dividing plate 2 2.

We are now prepared to divide an ellipsis geometrically, as shown by the points or dots forming the ellipsis 8 8, fig. 3, plate XVIII. The lower radial bar must be screwed forwards to coincide with the transverse radius, and the upper radial bar, to the conjugate radius of the intended ellipsis, and the index 7 7, be set to that circle of the plate 2 2, which is divided into 360 parts; that number subdivided by 10 being equal to 36, or the number of points in the ellipsis; then place the mark in the middle of the index 7 7, so as to coincide with the number 360 on the dividing plate 2 2; put down the tracer, and make a dot; then take it up again, and turn the winch or handle 6, till the 10th division on the dividing plate coincides with the mark on the edge of the index; again put down the tracer point, and thus proceed until all the points are marked round the intended ellipsis, when each side and each end of it will be found to be divided similarly. If, however, the radial bars were so adjusted as to describe a right line instead of an ellipsis, the divisions on such line, made by the above process, would be found to be equal to a line of sines, extending each way from the middle of the line, which is of essential importance in representing the teeth of wheels, viewed edgewise, as in fig. 4, plate XX.

In dividing ellipses perspectively, the dividing plate 2 2, must be moved eccentric along the grooves 3 3, in the wheel 1 1, so as to coincide with the distance of the vanishing point, and centre of the picture.

Previously, however, to making use of the machine for this purpose, it will be necessary for the reader to be acquainted with the rules of perspective; at least so far as

to be able to delineate the squares in which the circles or ellipses are to be described, in their various situations to the plane of the picture; as for example, let a perspective square be given; to find the positions of the transverse and conjugate diameters of an ellipsis, to be delineated therein.

Fig. 1, plate XXV, A B C D, is a perspective square parallel to the horizon H L, and at right angles to the plane of the picture; and likewise situated to the left hand of the centre of the picture S, let *d*, be the distance of the eye from the picture; and G R, the ground line. Then, bisect the side of the perspective square C D, in E: and draw a line from thence to the centre of the picture S, which also bisects A B, in F; likewise bisect the sides A C and B D, in I and J; and draw a line through those points, cutting the line E F at K (which will be the centre of the ellipsis); next, let fall a perpendicular from E, and make E M, equal to the line I K; join K M; bisect that line at N, and through N, draw O P, at right angles to it, cutting G R, at O; then O, is the centre, from which, with a radius equal to O M, or O K, describe the semicircle Q M T, cutting G R, in Q and T; then draw the lines Q Z and T U, through the centre K, which will be at right angles to each other; and in the position of the transverse and conjugate diameters of the intended ellipsis.

It will next be necessary to find four, or which is more correct, eight points, through which the ellipsis must pass; this will be easily performed by converting the perspective square into an octagon, in the usual manner, and drawing the two perspective diagonals A D and B C, intersecting each other at *k*, which will be the perspective centre of the ellipsis; then through the centre *k*, draw the line *i j*, parallel to A B or C D; and *i l* F *a j n* E and *p*, will be the eight points required. It will however be necessary, previous to applying the instrument, to extend the lines forming the transverse and conjugate diameters, each

way from the centre, at least equal to the radius of the circular plate Y Y; then after having adjusted all the indexes of the instrument, to their zeros, place the lower sliding bar parallel and perpendicularly over the line T U, or the conjugate diameter extended; and the upper sliding bar to that of Q Z, or the extended transverse diameter; and likewise the two radial bars; then screw forwards the lower radial bar, till the tracer point coincides with the point *p*; then turn the radial bars a quarter round, until they are nearly parallel to the lower sliding bar, or to the line T U; then screw forwards the upper radial bar, till the tracer point coincides with the point *l*, on the line A D; then if the winch or handle be turned round, the tracer will pass through the eight points *l*, F, *a*, *j*, *n*, E, *p*, *i*; and the ellipsis will be delineated in the given square. If, however, a greater number of divisions be required, they may, I believe, be more easily performed by means of this instrument, than by any other method hitherto published. For example, suppose it be required to be divided into 64 parts; first, turn round the radial bars, until the tracer coincides with the point or division E, and loosen the binding screw G, which fixes the wheel 1 1 on the axis of the radial bar D; and turn the wheel 1 1 (without moving the radial bars), till the middle of the groove 3, which has the nonius in it; or where the numbers on the dividing plate 2 2, are marked, coincides with the fiducial edge of the index 7 7; the binding screw G, must then be tightened, to retain it in that situation; then turn round the wheel 1 1, till the tracer coincides with the point *i*, and slide the dividing plate along the grooves 3 3, eccentric, till the fourth part of that circle of divisions, which may have been selected from the above table, to divide the ellipsis into 64 parts: for instance 384 (that number divided by 6 being equal to 64), coincides with the fiducial edge of the index 7 7,

the mark upon the centre of which must also be adjusted to that circle of divisions, from time to time, as the operation proceeds, owing to its eccentricity, by sliding the stem of the index in its triangular hole in the pillar 4; then, if the dividing plate be turned one eighth of the circle, the tracer will be found to coincide with the point *l*; and by moving it another eighth, or half way round, the tracer will be at the point F; and by thus continuing the operation, or turning the plate one eighth at each interval, the tracer will be found to coincide successively with the points *a*, *j*, *n*, E, *p* and *i*, of the ellipsis before described, according to the rules of perspective.

The instrument is now properly adjusted to divide the ellipsis into 64 parts, or any other number, which 384 will admit of.

It will however be necessary to observe, that the perspective divisions will be the greatest, when that part of the circle of divisions on the dividing plate, which is the least eccentric, is brought to coincide with the fiducial edge of the index 7 7.

It will also be proper to observe, that the tracer must be adjusted to the point E, before the wheel 1 1, is fixed in the above situation, in all cases where the circles are at right angles to the plane of the picture; as the line E F, passes through the perspective centre *k*, to the centre of the picture S; and the divisions at E, being nearest to the eye (on the given circle), will appear the greatest; and those at F, the farthest from the eye, will be the least; but when the circle becomes an ellipsis, the divisions at the extremities of the transverse diameter, will of course be foreshortened; and appear still smaller, as the circle is situated on a plane, nearer to the horizontal line.

If the circle be situated opposite to the centre of the picture; the transverse axis of the ellipsis will be at right angles to the line S W, and the tracer must be adjusted to

the point W, in place of E, in fig. 1, as the line W S, will pass through the perspective centre of the ellipsis (*See* plate XIV.)

Fig. 2, plate XXV, A B C D, is the perspective representation of a geometrical square, containing a circle situated perpendicularly to the horizon, and obliquely to the plane of the picture.

Before applying the instrument to perform this operation, it will however be necessary, to find the situations of the transverse and conjugate diameters of the ellipsis, which is to be delineated in the square; which will be done, by bisecting the line D C, in E, and from that point, drawing a line E *v*, to the vanishing point *v*, in the horizontal line H L; and which will also bisect the line A B, in F; the lines A C and B D, must also be bisected by the line I J, passing through the centre of the ellipsis at K. Then from E, draw a line E M, at right angles to the line D C, or parallel to the horizontal line; and take the distance K I, and set it off from E, on the line E M; next, draw a line from M to K, and bisect it at N; through the point N, draw a line at right angles to the line M K, cutting D C, at O; then with the distance K O or O M, describe a semi-circle from the point O, cutting the line D C, at T and Q; then from the point Q, draw a line through the centre of the ellipsis K, and likewise another from the point T, which will be the situations of the transverse and conjugate diameters of the ellipses, as required: the line Q K, must then be extended each way, and the instrument be placed parallel with it, as in fig. 1. The same process of converting the square into an octagon, &c. as directed in that figure, must also be repeated in this case, to determine the extremities of the ellipsis; the principal difference between the two operations consisting in the line E F, of fig. 2, being drawn to

the vanishing point *v*; instead of being drawn to the centre of the picture S, as in fig. 1.

Plate XXVI, is another example of an important use of this instrument, being the perspective representation of a cylindrical toothed wheel, lying parallel to the horizon, and opposite to the centre of the picture. The horizontal line being 6 inches above the perspective centre of the wheel; and the distance of the eye, 12 inches. Before using the instrument, temporary perspective squares (equal in diameter to the tops and bottoms of the teeth, to the circles forming the inside of the wheel, the diameter of the hole in its centre, and the boss surrounding it) must be drawn, as usual, in the same plane; then, let fall a perpendicular C *c*, from the corner of the exterior square, equal to the length of the teeth; and form another series of perspective squares, parallel to those above, at that distance; it will, however, only be necessary to mark the diameters, indicated by those squares, on the line passing through the centre of the wheel, to the centre of the picture; which will be the conjugate diameters of the ellipses; the transverse diameters will be the same as those in the squares, which form the upper surface of the wheel. Diagonals must then be drawn, from the opposite corners of the squares, to find (by their intersection), the perspective centre of the wheel; and also a line *i j*, parallel to A B or C D, through that centre; and another E F, at right angles to it, passing through *k*, to the centre of the picture. Then *i*, F, *j*, E, will be four points, through which the ellipses, bounding the extremities of the teeth of the wheel, must be drawn. Next bisect E F at K; and draw another line I J, parallel to *i j*, which will be the situation of the transverse axis; and E F, the conjugate diameter of the ellipsis; the lines I J and E F, must also be extended each way, for adjusting the situation of the in-

strument. Then, having adjusted all the indexes to their zeros, place the lower sliding bar parallel and perpendicular to the line E F, and the upper one to the line I J, which will be readily done, by placing the two lines produced from the 90 degrees on the opposite sides of the circle Y Y, for that purpose, in contact with the line E F, and the two zeros at right angles thereto on the line I J; the tracer will then be at the point K, in the centre of the intended ellipsis; then screw forwards the lower radial bar, till the tracer coincides with the points, *i* or *j*; next, turn the radial bars, till they are perpendicular to the line E F; and screw forwards the upper radial bar till the tracer coincides with the points E or F, in that line; then turn the radial bars to *i* or *j*, and observe whether the tracer coincides with these points; if not, adjust them accordingly; then turn the radial bars to the point E, and loosen the screw G, which fixes the wheel 1 1, on its axis; and turn the wheel, till the centre of the groove 3, or the commencement of the divisions, coincides with the fiducial edge of the index 7 7, and fix it in that position; then turn the wheel 1 1, together with the radial bars, a quarter round; or till the tracer coincides with the point *j*; and move the dividing plate 2 2, eccentric, along the grooves 3 3, until the fourth part of that circle of divisions upon it, which has been fixed upon, to divide the wheel into the required number of teeth (in this case 360; that number divided by 5, being equal to 72, the number of teeth in the wheel), coincides with the fiducial edge of the index 7 7, which will be the required degree of eccentricity, at that distance from the centre of the picture. The tracer must then be again brought back to the point E; and the nut *c*, on the screw W W, must be unscrewed, equal to the distance E, *e*, or length of the teeth; then the frame A A, will be at liberty to move that distance to draw the lines forming the sides of the teeth.

The instrument being now properly adjusted to draw the lines, which form the faces of the teeth, we shall proceed to give an example thereof. Turn the wheel 1 1, till the commencement of the chosen circle of divisions on the dividing plate 2 2, coincides with the fiducial edge of the index 7 7, and put down the tracer; then turn the dividing plate, 2 divisions, which will be equal to *y z*, or the width of the end of the tooth; then move the wheel A A, eccentric to the right, till the nut *c* stops against the stud *w*; and the line *y x*, will be drawn; forming one side of the face of the tooth; then turn back the dividing plate the two divisions, and the line *x w*, will be drawn, forming the lower end of the face of the tooth; then move the frame A A, to the left, till the nut *d*, on the screw W W, is stopped by the stud *w*, and the line *w z*, will be drawn, which completes the face of the tooth. The tracer and dividing plate being now again in the position where we commenced the operation, the tracer must be raised, and the dividing plate turned five divisions (which will be equal to the breadth of the tooth, and the space between it and the next tooth); and the tracer being put down, a similar process must be performed, to describe the face of the next tooth, and repeated, until we come to the point I, when, as the faces of the teeth are no longer visible, it is only necessary to draw the lines, forming the widths of the teeth, until we arrive at J, when the sides and faces of the teeth will again appear, and must be drawn as before. The radial bars must next be adjusted, till the tracer coincides with the perspective points *o*, P, *q*, *r*, of the square, circumscribing the segments of the ellipsis, which forms the extremities of the bottoms of the teeth; it will also be necessary, at the same time, to move the frame A A, a little in the direction of the line K E (as the transverse axis of this second ellipsis is not in the situation of the former one), and the eccentricity of the divid-

ing plate 2 2, must again be adjusted, so that the tracer coincides with the point *o*, when turned 90°, and the nuts *c* and *d*, on the screw W W, must be also adjusted, to limit the lengths of the lines forming the sides of the bottoms of the teeth. The instrument will now be prepared for delineating the segments marking the spaces between the bottoms of the teeth, and also the basis or sides of the teeth; the dividing plate 2 2, must again be turned, till the commencement of the circle of divisions coincides with the index 7 7; and the tracer will be at the point *r*, of the base of the tooth we first commenced with; the tracer must then be raised, and the dividing plate moved one division and a half towards the left hand, the tracer put down, and the operation proceeded with, as described in drawing the faces of the teeth.

Having now obtained the breadths of the tops and bottoms of the teeth, the curves forming the sides of the ends must next be drawn, which may be done by the instrument; but as the process is more tedious than drawing them by hand, the latter method is to be preferred; the four extremities or corners being already delineated, as above described. Then the frame A A, must be again moved in the direction of the line K L, and the radial bars adjusted, so that the tracer coincides with the points *s t*, *u v*, through which draw the ellipsis, forming the upper side of the interior of the rim of the wheel, and divide it perspectively for the extremities of the arms of the wheel; then adjust the frame A A, and the upper radial bar, so that the tracer coincides with the points *m n*, being the conjugate diameter of the ellipsis, forming the lower angle of the interior of the rim; and draw such parts as can be seen, and also the ellipses *a a*, and *b b*, forming the exterior and interior of the eye of the wheel, as well as part of another *d d*, denoting the depth of the eye must also be delineated. The instrument being then removed,

the arms may be drawn, which will complete the delineation of the wheel in perspective.

The eccentricity of the dividing plate 2 2, of the instrument, may be adjusted to divide ellipses perspectively, in any given situation, by means of the scale and nonius in the groove 3, by the following rules: thus, let there be given the number on the dividing plate 2 2, 660; the radius of the conjugate diameter of the ellipsis 2,000, or, which is the same thing, 2 inches; the eccentricity of the dividing plate 118 (as marked by the nonius 3); and the distance of the centre of the ellipsis from the vanishing point, or centre of the picture, 10 inches; then to find the eccentricity of the dividing plate for any other distance of the vanishing point, or conjugate radius of the ellipsis should both vary, two operations will be necessary; the one by inverse, and the other by direct proportion, and which will be most readily performed by means of the sliding rule, as in the following example:

Suppose the distance of the vanishing point, from the centre of the ellipsis, to be 20 inches; the radius of the conjugate diameter 1,000, or 1 inch, and the number on the dividing plate 660; what will be the eccentricity of the dividing plate?

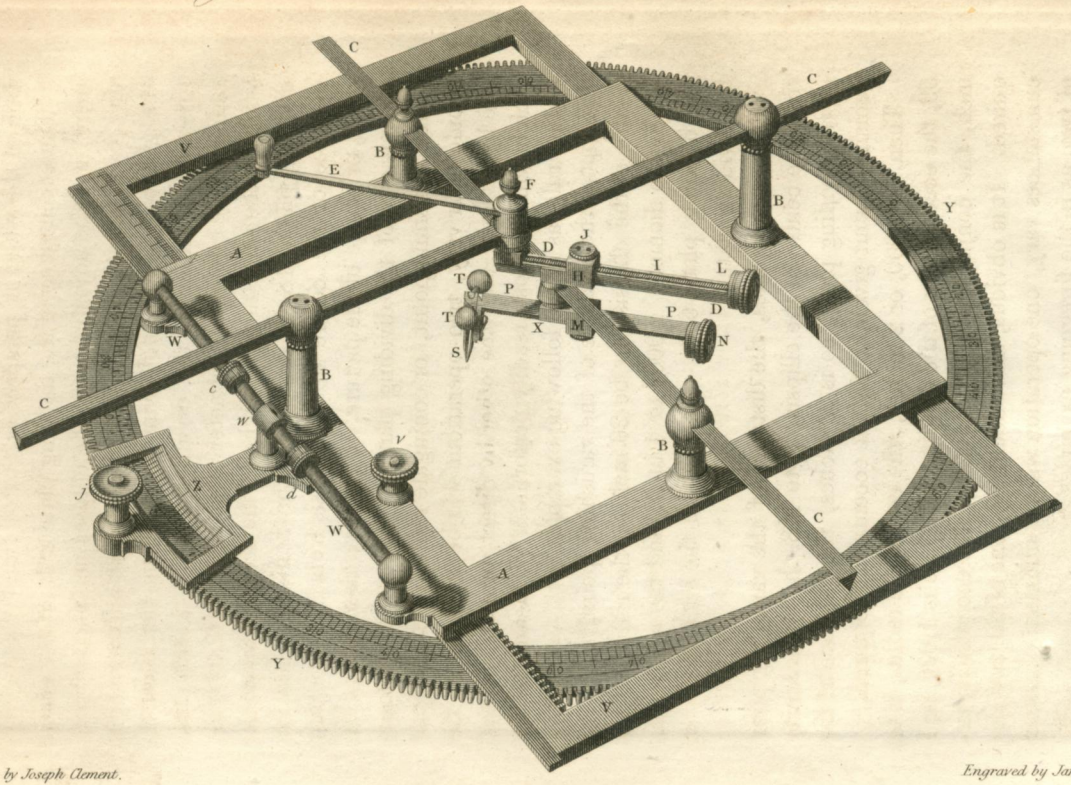
First, as 10 inches, the distance of the vanishing point from the centre of the ellipsis, is to 118, the eccentricity of the dividing plate, so is 20 inches, the distance of the vanishing point given, to 59, the eccentricity required.

Then, as 2,000, or 2 inches, the conjugate radius, is to 59, the eccentricity of the dividing plate, so is 1,000, or 1 inch, the conjugate radius, to 29·5, the eccentricity required. It is obvious, that should only one of the two circumstances vary, one operation will be sufficient, instead of two, as in the foregoing examples.

Should, however, any other circle of divisions on the plate 2 2, be chosen, instead of that divided into 660,

Mr. Joseph Clements' Instrument for Drawing Ellipses, &c.

Plate. 17.

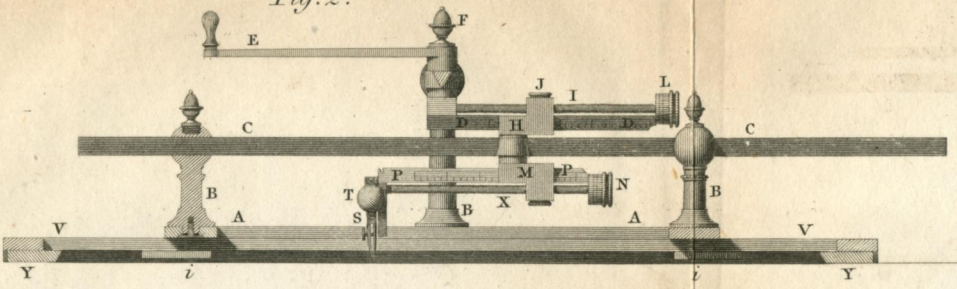


Drawn by Joseph Clement.

Engraved by James Davis.

Mr. Joseph Clements's Instrum

Fig. 2.



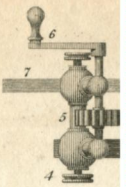
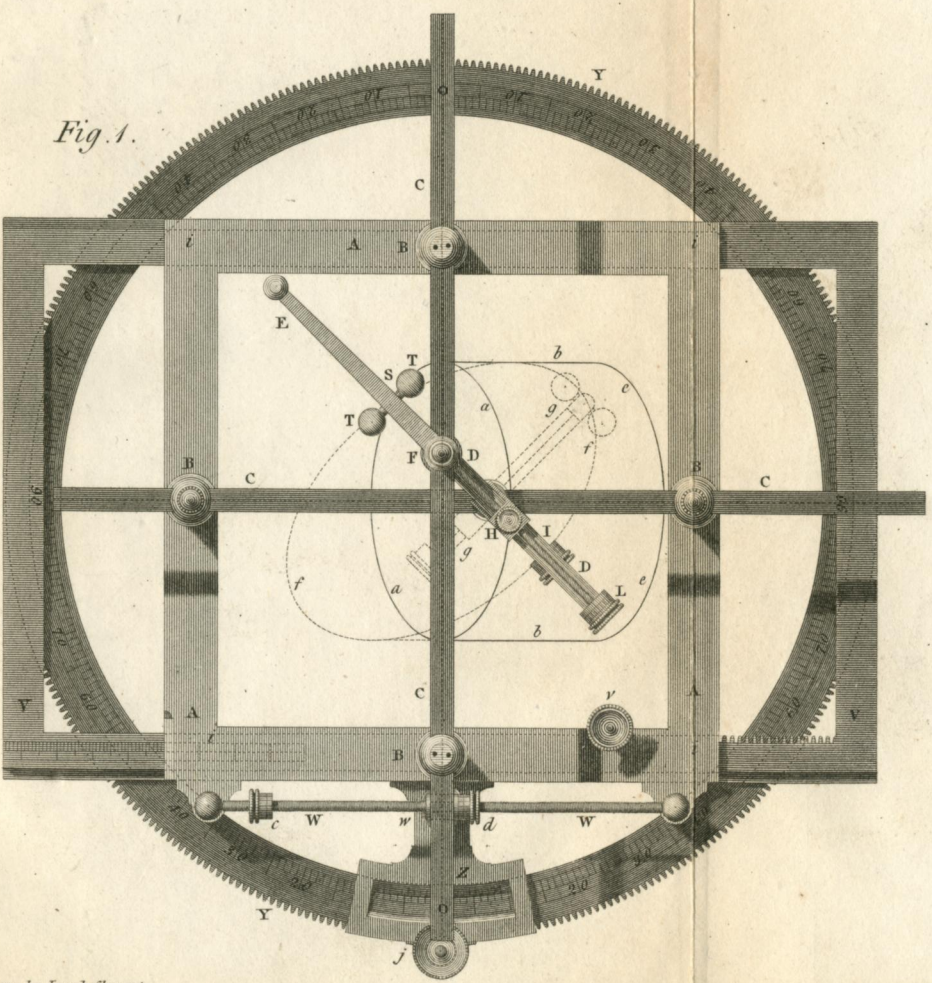
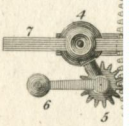


Fig. 1.





Drawn by Joseph Clement.

Instrument for Drawing Ellipses, &c.

Plate 18.

Fig. 4.

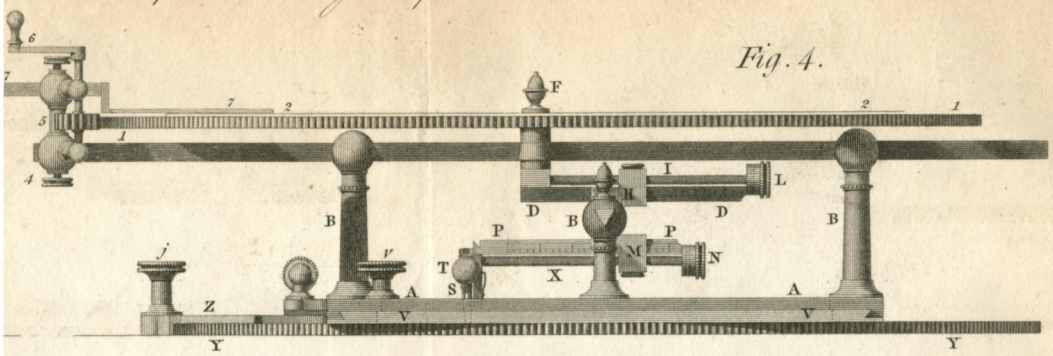
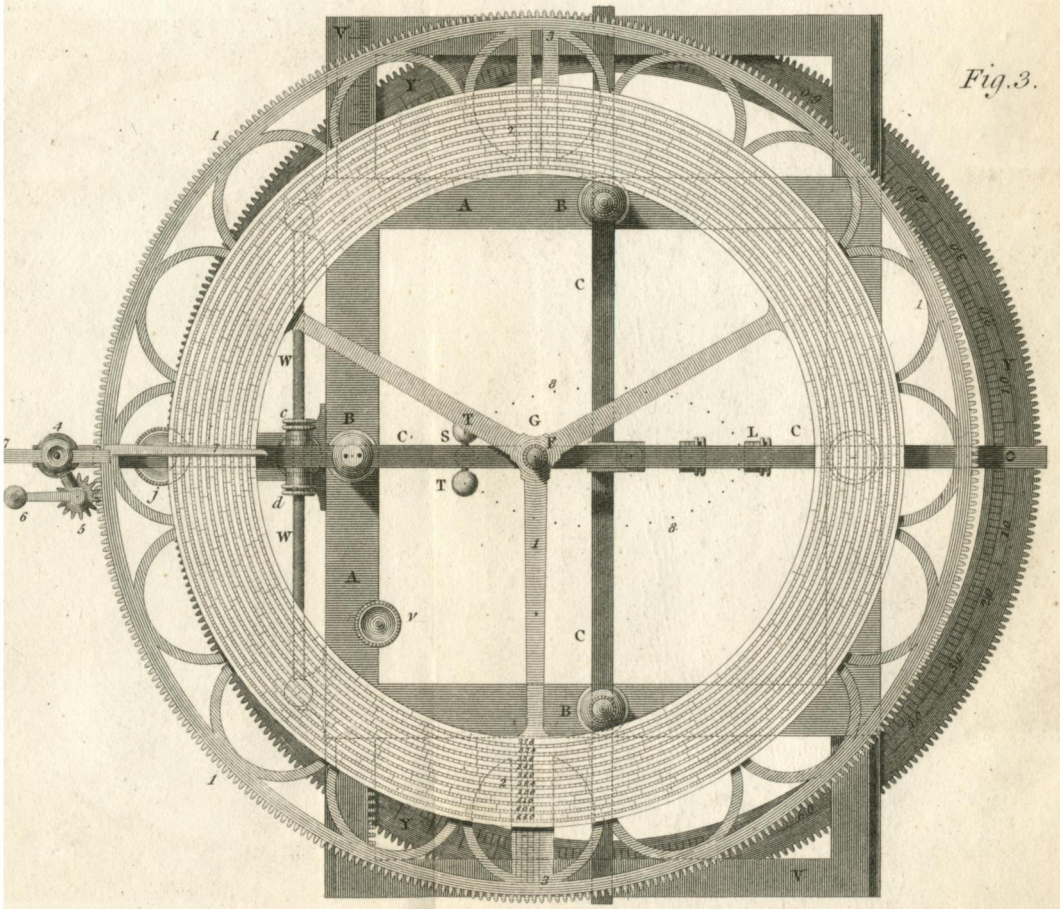
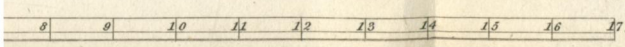


Fig. 3.





Engraved by James Davis.

Mr. Joseph Clem
for Drawing

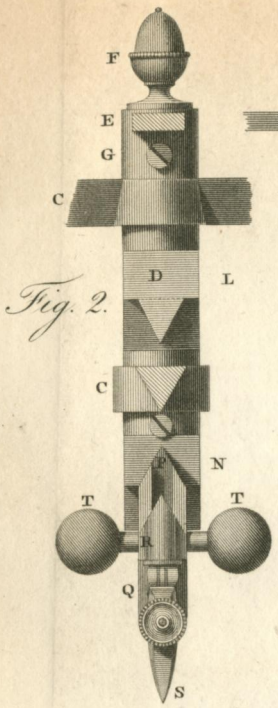


Fig. 2.

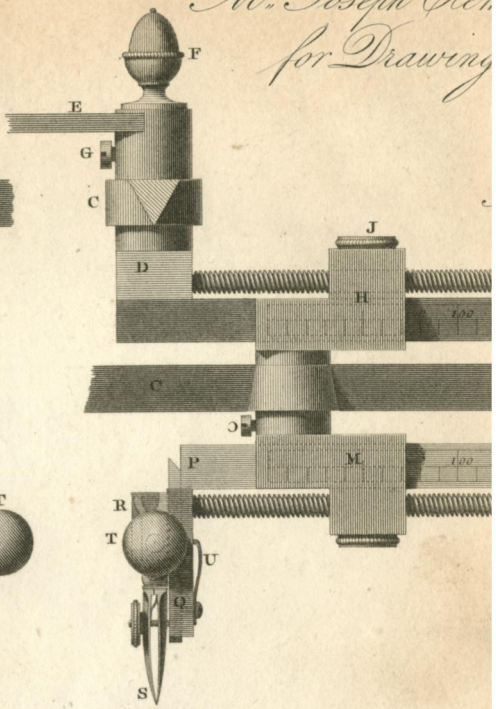
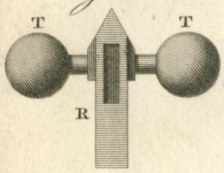


Fig. 4.



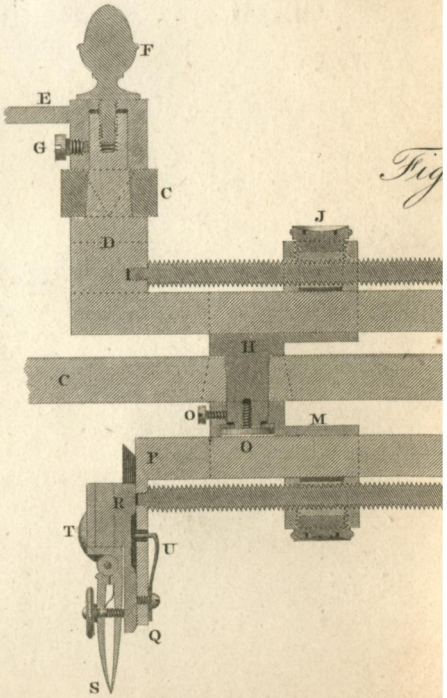


Fig. 5.

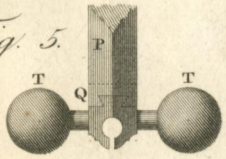
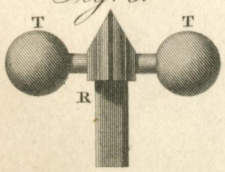


Fig. 7.

Fig. 6.



Drawn by Joseph Clement

Joseph Clement's Instrument
for Drawing Ellipses, &c. Pl. 19.

Fig. 1.

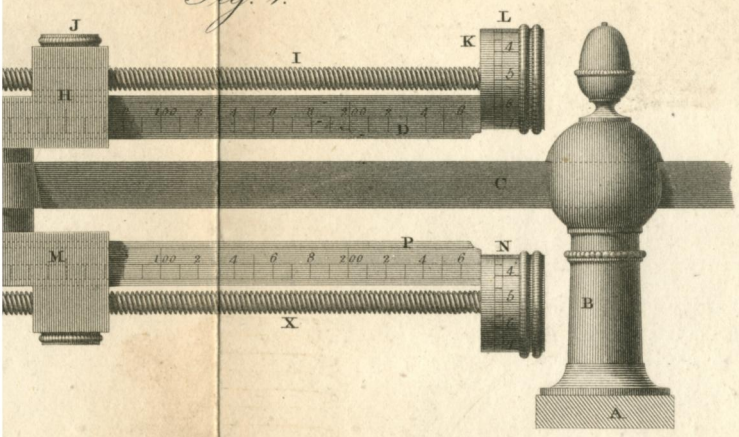
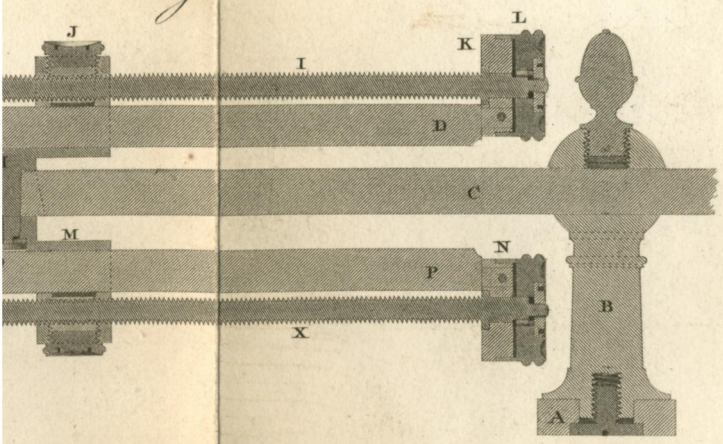


Fig. 3.



Engraved by James Basire

Examples shewing the use of Mr. J. Clement's Instrument.

Fig. 1.

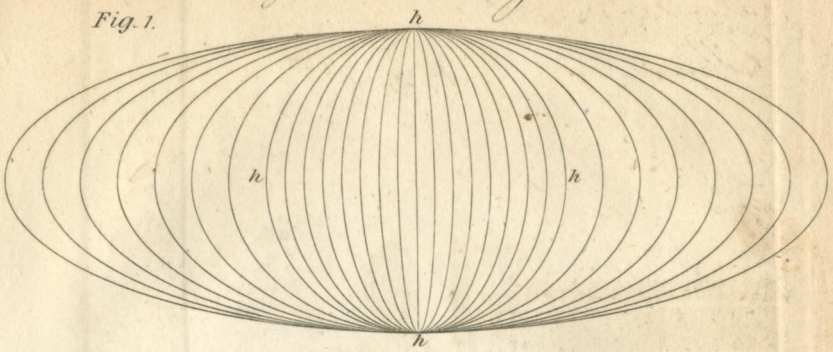


Fig. 4.

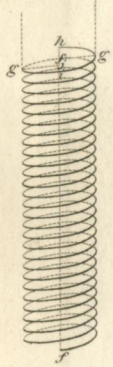


Fig. 2.

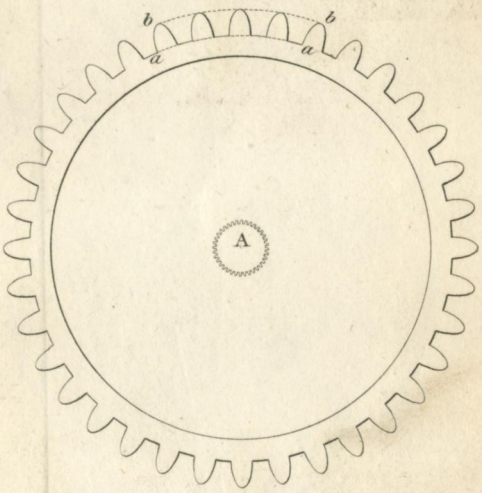


Fig. 6.

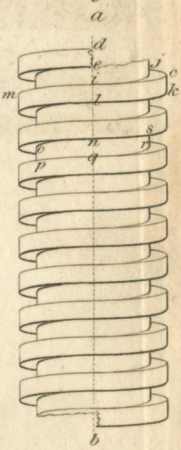


Fig. 5.

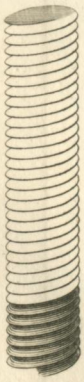


Fig. 3.

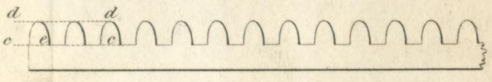
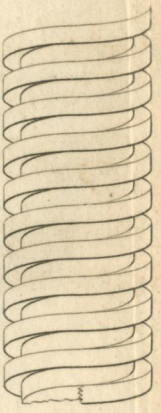


Fig. 7.



J. Clement & J. Davis Sculp.t

Examples shewing the use of Mr. J. Clement's Instrument.

Plate. 21.

Fig. 1.

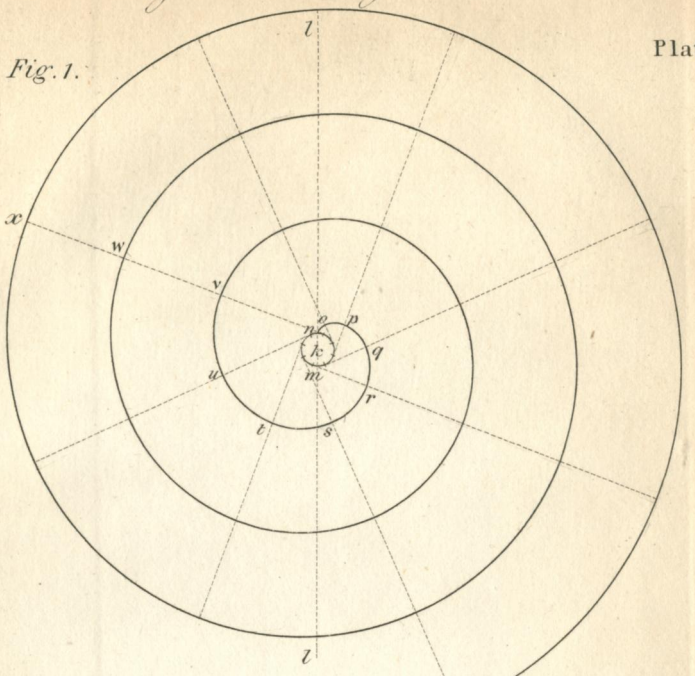
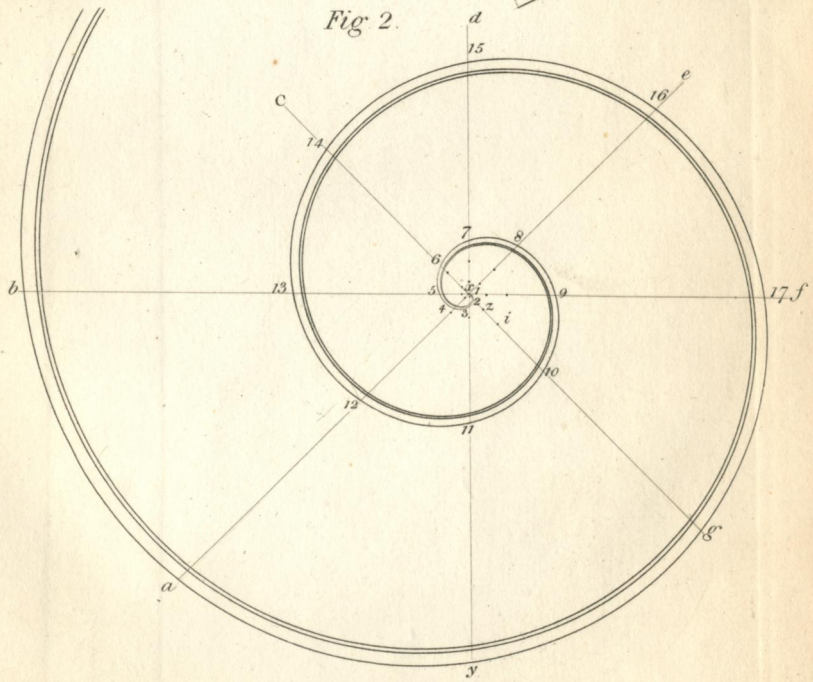


Fig. 2.



J. Clement & J. Davis Sculp.t

Examples shewing the use of Mr. J. Clement's Instrument.

Fig. 1.

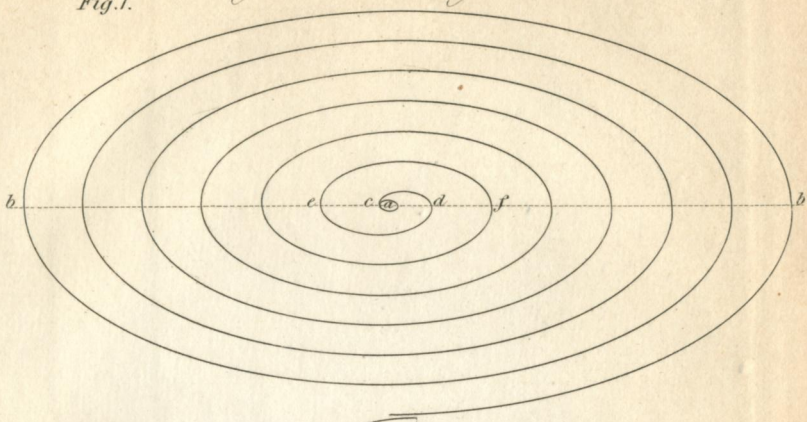
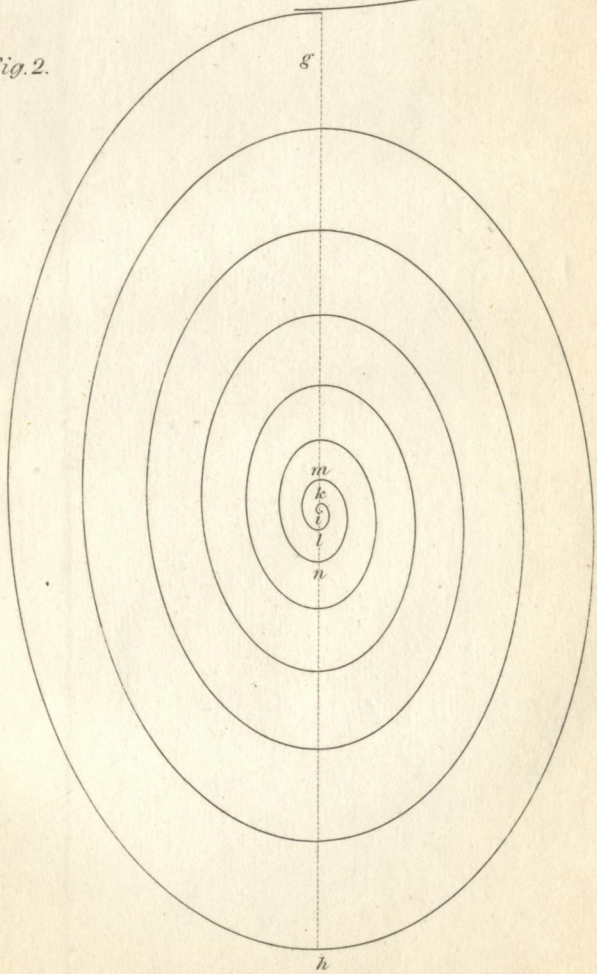


Fig. 2.



Geometrical Projections of the Sphere by Mr. J. Clement's Elliptical Instrument.

Plate. 23.

Fig. 1.

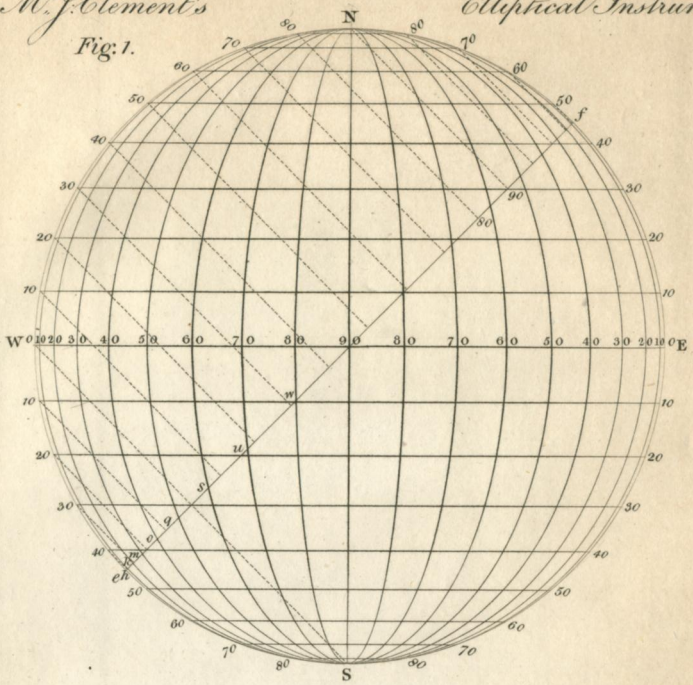
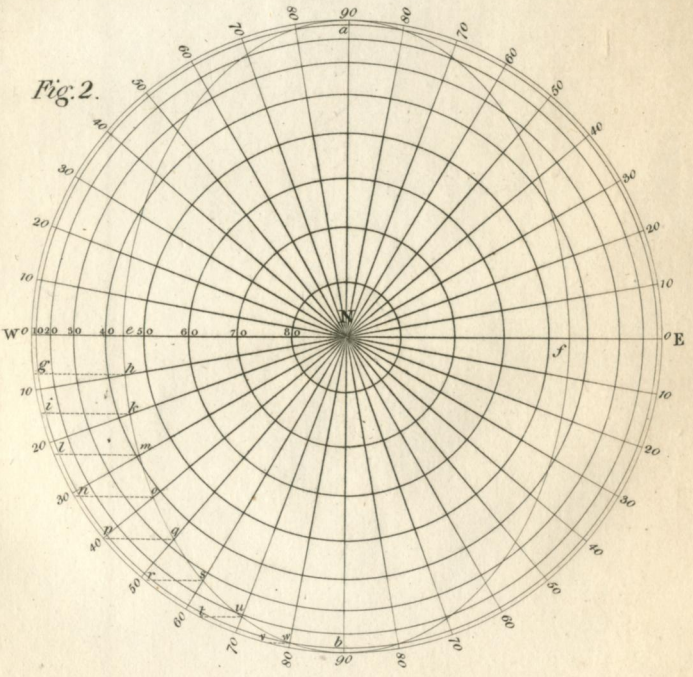


Fig. 2.



J. Clement & J. Davis, Sculp.

Geometrical Projections of the Sphere by Mr. J. Clement's Elliptical Instrument.

Plate. 24.

Fig: 1.

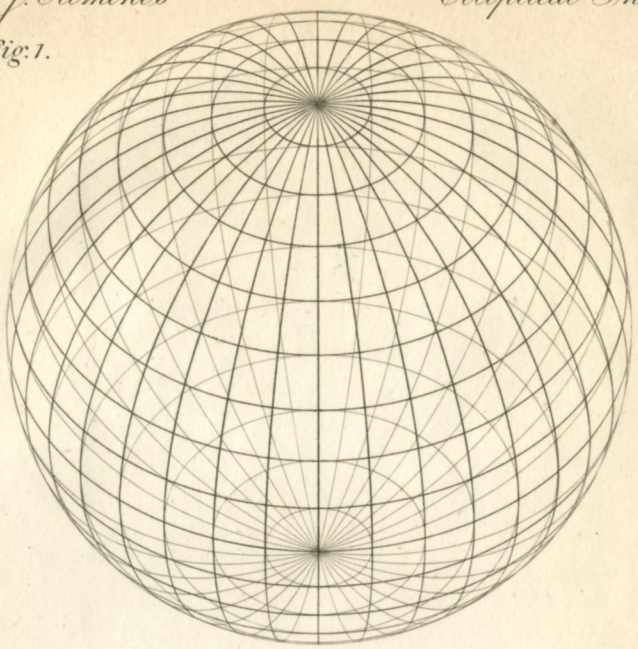
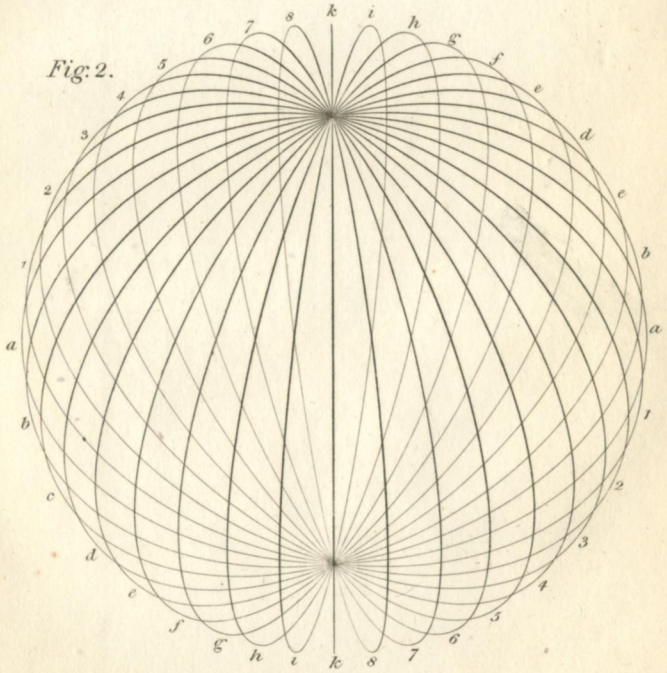


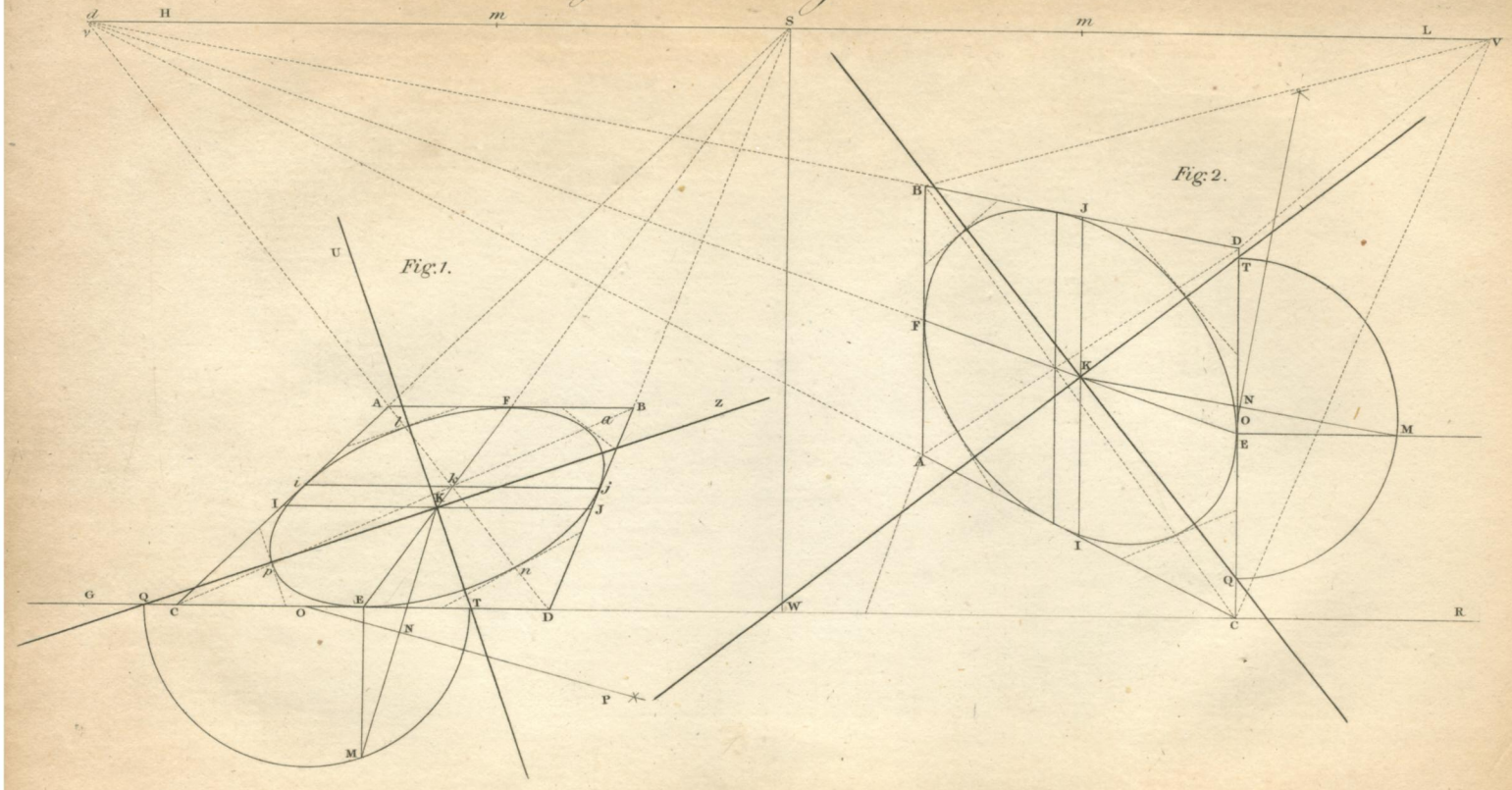
Fig: 2.



J. Clement & J. Davis Sculp.

Examples shewing the use of Mr. J. Clements Instrument.

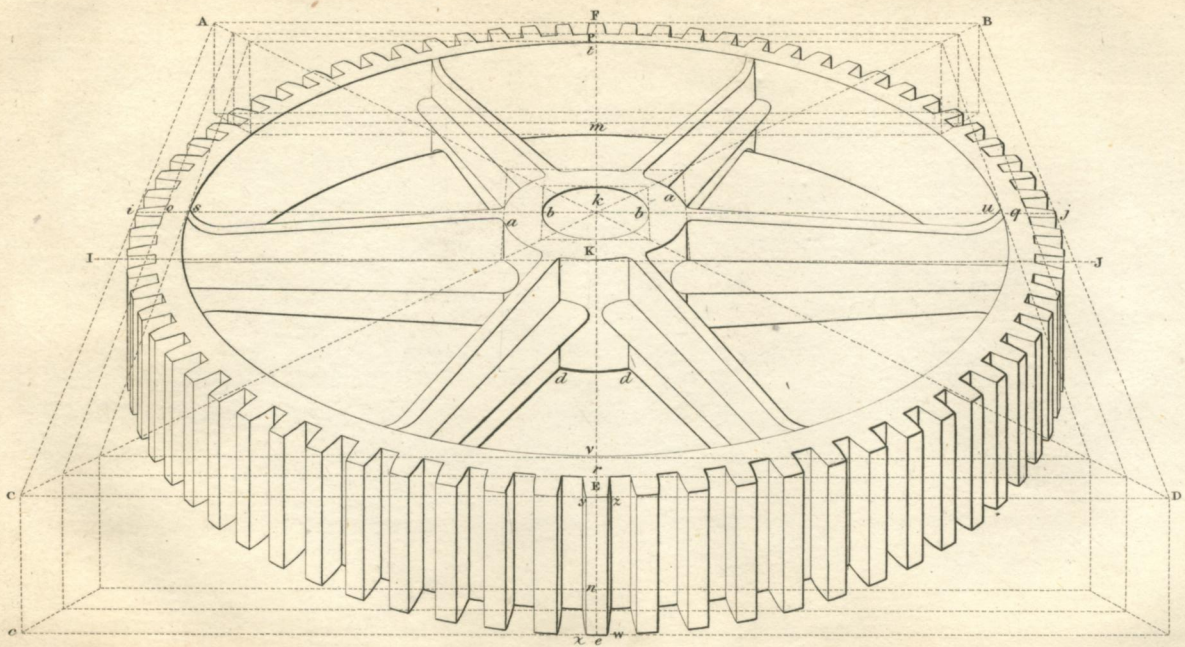
Plate. 25.



J. Clement & J. Davis, Sculp.

Plate . 26.

An Example of the use of Mr. J. Clements Instrument.



(which is the circle of the greatest radius on the plate), that circle would bear the same proportion to its eccentricity, as the radius of the circle of 660, does to 118, the eccentricity of the dividing plate; or, as the radius of 600, or the next greatest circle of divisions, does to the eccentricity 115; and so also will the remaining circles upon the plate, bear the same relative proportion to its eccentricity; as shown by the following table.

As the number 660 is to 118, the eccentricity of the [dividing plate

So is	600	to 115
	510	to 112
	390	to 109
	384	to 106
	360	to 103
	342	to 100
	336	to 97
	324	to 94
and	376	to 91

The uses of the instrument are however by no means confined to the few examples here given; but it will be found of the utmost advantage in mechanical and architectural drawing in general; and particularly from the great facility it affords of delineating the different curves, in the various situations where they are required; a property which no other instrument, hitherto invented, possesses in an equal degree.